

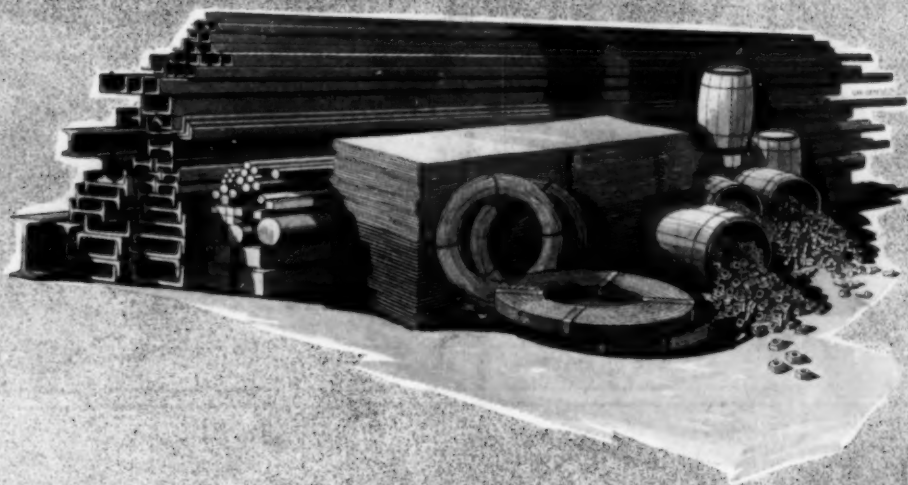
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McGraw-Hill Co., Inc.

November 23, 1921

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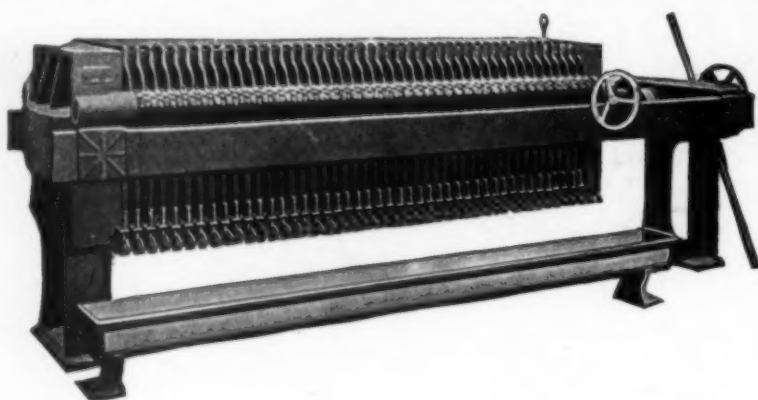
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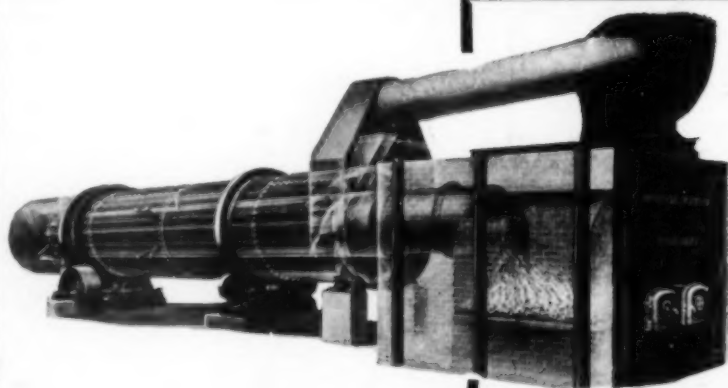
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Volume 25

New York, November 23, 1921

Number 21

Pointing the Way To Industrial Peace

FRIENDLY criticism is always welcome, especially when it comes from one who has succeeded in solving some of the same sort of problems that have been puzzling us. And this is one of the accomplishments of B. SEEBOHM ROWNTREE, a highly successful manufacturer of York, England, who has spent two months in the United States studying methods and conditions in our industries. His public addresses have been of particular interest to American business men because they offer a keen analysis of our industrial relations by one who is recognized as an authority on the social aspects of industry.

Mr. ROWNTREE tells us that although the American manufacturer leads the world in the application of science to the material problems of his business, his relations with his employees are still guided by the crudest of rule-of-thumb methods. He is willing to spend his money for costly excursions into abstract science, but he is often inclined to regard the recommendations of his industrial manager as too idealistic to be of practical application. The American executive attempts to increase the efficiency of his plant by improving industrial processes and by eliminating wastes in production, but he does not give commensurate consideration to the problems of labor and its growing spirit of unrest. The British manufacturer, although perhaps not quite as alert nor as aggressive, has far outstripped his American brother in the progress toward industrial peace. He has put into actual operation many of the schemes which appear Utopian to most of us.

Our visitor's principal criticism of the employer, as a class, is that he is unimaginative. He sees business through his own eyes, to which labor is but a commodity which disturbs his plans and threatens his profits. As long as this attitude remains unchanged, industrial unrest will continue to be regarded as a necessary adjunct of industry. Mr. ROWNTREE maintains that such a misconception can and must be corrected, but that this will not be accomplished by conflict nor by any scheme which attempts to recast or revolutionize the entire industrial system. He gives us five minimum conditions which, in his opinion, constitute the price which must be paid for industrial peace: (1) Wages must be sufficient to permit the worker to live in reasonable comfort. (2) Working hours must be such as will give the worker adequate opportunities for recreation and self-expression. (3) There must be an increased economic security for the worker, notably with regard to the menace of unemployment. (4) The employee must share with the employer in determining working conditions. (5) The worker must receive a direct interest, if possible, in the profits of the industry in which he is engaged.

Many American manufacturers will no doubt offer practical objections to this platform, but the fact remains that in Great Britain most of these principles are being applied with conspicuous success. Unemployment measures, wage equalization funds, pensions, workers' councils and profit-sharing schemes have made greater headway in British industries than in our own. If it is true that our industries have had a lopsided development, that we have emphasized the material and neglected the human aspects of business, then American executives can profit by Mr. ROWNTREE's friendly criticism and constructive suggestions.

Classification Of Research

IN THE department headed "Readers' Views and Comments" is published a letter from Dr. HYDE, commenting upon our editorials entitled "When Is a Research a Mere Inquiry?" (Oct. 5) and "How May Research Be Fostered?" (Oct. 12). Dr. HYDE calls attention to a classification of research activities published in the first of these editorials, and ascribed to him, but which is in error. The editors must plead guilty of the fault, and gladly give space to the diagram used by Dr. HYDE, a duplicate of which was unfortunately not in hand. Inspection of the two will show that both of us are in agreement that "Research" should not apply to all kinds of work mentioned—in fact Dr. HYDE classifies some of it as plain "Engineering" rather than "Engineering Research."

Obviously we made no effort to appraise research activities in a critical manner and from many angles. An opportunity was taken, however, to protest in as vigorous a manner as possible—and to this end we used certain literary license in overdrawing an opposite picture merely to emphasize the point—against an indiscriminate use of the word "Research." Fortunately, perhaps, for the English language, the dictum of even so powerful an organ as CHEMICAL & METALLURGICAL ENGINEERING is unable to change the accepted usage of words! And since dictionaries follow usage rather than lead in developing language, definitions of research can easily be found that would include those investigations that Dr. HYDE wishes to exclude. And doubtless a little search in our own columns would convict us of the same fault against which we are declaiming.

Nevertheless, we beg of you, be a little more careful in the use of words—precision in this is as desirable as in any other activity or observation. There are real differences between research, investigation, inquiry, scrutiny, experimentation, testing. With the wonderful resources of the English language available, it is a shame to debase it into jargon. Not all experimenters are researchers; not all surveyors are engineers.

Apropos of Getting a Job

HE WAS a graduate chemical engineer from a good institution, and looking for work. He asked the old man if he couldn't recommend him somewhere. The old man asked him in return to name any of his qualifications that he could indicate as warranting his employment. The younger one thought the name of his *alma mater* a sufficient guaranty of his merit. Then the old chemist proceeded:

"The open door of opportunity is narrow and there are many trying to crowd through it. You stand now on the outside of the crowd, all trying to get in. On the other side of it a few good men are wanted, but are you any better than the rest of the crowd?"

"No, I don't profess to be a genius. All I claim is to be a good graduate chemical engineer without experience."

"I'm afraid you are not even a good graduate. Here is American industry sorely in need of applied chemistry, and hardly anyone to apply it until somebody shows the world just how it is done. That's the trouble with you fellows outside the door: you're unwilling to think. You want to get in, and then have somebody nurse you along until you are taught enough things that others know, to have earning capacity. It is a proper attitude for an apprentice, but it is not the proper attitude for a professional man."

"Let's take a look about us. There is the sulphuric acid works, the rubber works, the coke plant, and the tar refinery. You say they don't want any more chemists, and you observe the crowd trying to get in. If you were to succeed, I doubt if you would be of much use to any of them. You will have to be born again, if you want to be a good chemical engineer, and what I am trying to do now is to start you in the process of being born again."

"Do you see the big bakery over there? See the candy factory? See the two big laundries? See the new hotel with its immense restaurant?"

"But they don't want any chemists!"

"Yes, they do. They don't wish for them, but chemistry is just what they lack. Of course the men at the head of the concerns don't know it, but that is where your chance comes in. If they knew they needed chemists, they would call for specially trained men, and you wouldn't have any show at all. When your friend STEVE first went to a pulp mill he knew the superintendent didn't want any chemists. He hadn't any use for theorists, he said. It was the same old story that the administrator of every one of these establishments would tell you if you asked for a post as chemist with them. STEVE took a job as a yard rustler, and despite the backache from unaccustomed work, he climbed around in his leisure and made tests and discovered not only shocking losses, but worked out plans whereby they might be completely avoided. He didn't talk until he was sure that what he had to say meant dividends. Then this yard rustler who was also a graduate chemical engineer opened up and the authorities had to listen. Did they listen because he was a graduate of Massachusetts Institute of Technology? Not on your life! And look at him today! He is one of the leading chemical engineers of the country, while some of his classmates are doubtless still making routine tests!

"If you start in as a dishwasher or a porter or a de-

livery clerk in any of those establishments I named and keep constantly using your head, never forgetting the chemical aspect of every problem that comes up, reading up the literature and corresponding with men who know more than you do, your chances are a hundred per cent better than those of any of the fellows who are trying to get through the open doors. If you are discouraged today with all the opportunities awaiting the man who looks for them, it is because you can't think for yourself, or because you won't. If you can't think for yourself, you'd better quit chemistry. If you merely lack the habit of thinking for yourself, it is time to acquire it. That is being born again!"

Signposts of Metallurgical Progress

IT IS perhaps trite to remark that Americans are prone to become provincial, and that a study of conditions abroad would do much to improve their perspective. Even so, we repeat that much the same forces are moving in industry both here and abroad—we may not be able to see them ourselves and at home, but we can discern them in the foreign situation, or can be told them by European visitors.

The French have long been noted for a peculiar excellence and artistry in their manufactured products, yet Professor CAVALIER, French exchange professor in the United States, in a statement on "Problems and Progress of Iron and Steel Metallurgy in France," written for the American Society of Mechanical Engineers, says:

The war, in bringing together for the national defense the industrialists and the men of science in the process of intensive production of metal, has powerfully contributed in France to the employment and to the diffusion of new and precise methods of work and of control. In the development of the use of scientific methods, the progress realized by systematic study in the laboratory usually penetrates slowly into industrial practice. Producers in the average industry have a tendency to consider the laboratory as a luxury which does not pay. Without doubt these good industrial habits which were acquired under the force of circumstances will continue. And thus the war will have contributed to the progress of our metallurgical industry, even though it be in a measure which only compensates to a slight extent for the great losses resulting from the destruction of our factories.

Here is a general statement of the advantage of science to industry—but sometimes "science" is little more than close observation and the application of common sense. A particular instance of this infusion of common sense into industry was noted some time ago in these columns—an instance drawn from some remarks of EUGÈNE SCHNEIDER, when he showed it to be possible to reduce large ingots to gun tubes in 11½ days and seven heatings, whereas 43 days and nine heatings were the usual allowance. Why build greater shops if the old ones can do this?

Lastly, an eminent European metallurgist recently in this country expressed to a party of friends his personal opinion that American metallurgical industry, especially in the East, was greatly overbuilt. "This being granted," he continued, "it is evident that there will be the keenest competition for the available business. Much of it will go to the lowest bidder, who ordinarily will have perfected his methods so that he can produce at an extraordinarily low price, but I am confident that a larger and larger proportion of the business will go to the people who can put quality into their product, as well as into their management and production methods."

The Railroad "Problem"

THE railroads are poor. There is no doubt about that, for the railroads themselves admit it. By this time it ought to be clear that the railroad "problem" is like the poor, in that we have it with us always. Who can remember a time when there was not a railroad "problem"? Back in the 1880's the problem was "rebating," etc., and how to stop it. In 1887 came the original interstate commerce act. Ever since it has been just one thing after another.

An outstanding feature of this practically continuous performance is that the issue has been so different at one time and another. For instance, there were certain periods before the war when nearly every business man, and nearly every business review, was saying that business would not be really good until the railroads were permitted to advance their rates. Of late the chorus has been shouting that business will not be good until rates are reduced.

Perhaps the explanation is that it is psychological. Railroads are a good thing and—what is more to the point—an easy thing to talk about. The railroads are almost ubiquitous. Everybody patronizes the railroads directly or indirectly. Then the stockholders and bondholders of the railroads are very numerous. Next, a couple million or so persons are employed by the railroads. Last, but by no means least, particularly when one judges by the amount of noise made, are those that sell or would like to sell to the railroads.

The railroad problem, or question, or subject of debate, has fallen in various categories. Sometimes it is said to be a political matter. At other times it is "an economic question," while at other times it is said to be just plain business. Other things may be important, but men do not feel themselves so directly interested nor do they have the same unbounded confidence in their ability to discuss them and to cite to the man buttonholed convincing facts if only the buttonhole will stand the strain.

Business is not as good as men would like to have it, and there is nothing more convenient on which to blame the condition than freight rates. There is a fine slogan: "Everything else has been liquidated—why not freight rates?" Then details are entered into. The railroads have not been earning the expected return on valuation, which is only 6 per cent, but if rates were reduced there would be more business and so the railroads would make more money after all.

The first freight blockade or congestion in the history of American railroading occurred in the winter of 1902-1903. In recent years such blockades have been frequent, and on each occasion it has been urged that we must have improved transportation facilities and the public can afford to pay for the improvement. The popular conception seems to be that light railroad earnings, an average of 2.6 per cent on valuation in the eight months January to August inclusive instead of the desired 6 per cent, are the evidence of traffic being light. The physical volume of traffic, however, is reported, the public paying little if any attention. In the first eight months of this year the ton-mileage was only 24 per cent under that in the same period of 1920, and 1920 was the record year for freight movement. Last August the ton-mileage was only 29 per cent under that of

August, 1920, the record month in all history for freight movement. The way is not as easy as is assumed for the railroads to obtain a large increase in business and handle the business satisfactorily.

Chicago Citizens

Support Landis Award

PUBLIC sentiment on the labor union situation in Chicago has crystallized to a definite action which should be far reaching in its effect on all industry. One hundred and fifty business men and representative citizens have organized under direction of the Chamber of Commerce into a body known as the Citizens Committee to Enforce the Landis Award. It is to be a permanent organization with the purpose of bringing about 100 per cent adoption and enforcement of the terms and conditions laid down by Judge LANDIS in the building arbitration decision.

A statement issued at the first meeting on Nov. 10 shows that two months has elapsed since Judge LANDIS gave his award in the building controversy. Prior to that time Chicago for years paid tribute to dishonesty, graft and various forms of extortion, and conditions have grown more intolerable each year. Investors have hesitated to supply funds for building because of extravagant cost. Business expansion has halted because of excessive overhead. Industries have feared to take advantage of Chicago's natural facilities and market position because of the city's reputation based on conditions in the building trades.

In spite of the agreement of contractors and building trade unions to participate in the arbitration, some of the contractors and some of the unions have proceeded to work without regard for the award. Continuation of the present trend will place Chicago in an even worse condition than existed before. The real program of expansion and the relief so sorely needed will not occur.

The committee will make no fight on the trade unions as such. Those unions which in letter and spirit have accepted the Landis award and are working under it will have the support of the citizens. Those behaving otherwise will automatically lose the support of the public. Those contractors who have entered into agreements with unions outside of the award deserve neither the consideration nor the support of the public.

Thinking folks desirous of fair dealing for all branches of society carry the balance of power in the United States. When it becomes otherwise we are lost. They are slow to move, but once under way become irresistible. This is only one of many instances where a chamber of commerce with right ideals serves as an activator to facilitate public reaction. We believe this committee will succeed in its undertaking.

Pitiable End of

A Russian Scientist

WE ARE informed by Colonel A. I. KRYNITZKY, an expatriated Russian at present on the staff of the Bureau of Standards, that the venerable Prof. TSCHERNOFF, international authority on metallurgy, has succumbed to privation. A letter from his younger son contains the information that the widow, Mme. A. N. TSCHERNOFF, and one of their daughters live at Petrograd, Sergievskaja St., No. 1, Apartment 1, under most miserable conditions.

Readers' Views and Comments

Classification of Research Activities

To the Editor of Chemical & Metallurgical Engineering

SIR:—I am very appreciative of your letter of Nov. 3 containing copies of the two editorials which appeared in *CHEMICAL & METALLURGICAL ENGINEERING* Oct. 5 and 12, 1921, and which were prompted largely by the paper which I presented before the American Society for Steel Treating in Indianapolis.

No doubt the idea in the mind of the writer of the first editorial is the very laudable one of placing research on a high standard and excluding all that which is unworthy of the name. I am heartily in accord with him on this point and am inclosing a reprint of a paper entitled "The Methods of Research" which I presented before the Illuminating Engineering Society about nine years ago and which had for its object the discouraging of those many abortive efforts which are put forth in the name of research. Unfortunately, however, the editorial writer of your journal has, in my judgment, discriminated on the basis of the material of research rather than on that of the ideals and methods of research.

We may quarrel with regard to the extension of the meaning of the word research to include investigations in other than in pure science, but by the dominating power of common usage the term has taken on a wide significance. In view of the fact that this wide significance has been crystallized in the very name of the National Research Council it is unfortunate that a criticism of its use, such as that which was connoted in the editorial, should be made. In accordance with the accepted significance of the term, the investigation of the phenomena which underlie successful electric welding must be termed research equally with the investigation of the ultimate structure of the atom. I find that this apparent unwillingness to admit the extended use of the term is as evident in the second editorial as in the first.

I should like to add a further word of comment with respect to the second editorial. The writer apparently disregards the classification which I have suggested, by which pure scientific research is divided into "frontier research" and "intensive co-operative research." We are in agreement that frontier research should be carried on in universities and privately endowed laboratories. I am strongly of the opinion, however, that that which I have termed "intensive co-operative research"

is a legitimate and even a necessary function of industrial corporations.

Finally I should like to call attention to the fact that the classification given in the editorial is not correctly taken from my chart. There is one mistake of a fundamental character and one of relative unimportance. The former is the classification of Engineering under the general head of research. According to my chart Scientific Research and Engineering are to be distinguished, although under Engineering there is one link to research. The relatively unimportant error is that number 5, "Engineering Practice," has no part whatever with research and is, therefore, performed by corporation and private engineers and not "in corporation and private laboratories" as stated.

I am sending you the chart which served as the basis for my discussion.

I thank you for this opportunity of replying to the two editorials.

EDWARD P. HYDE.

Nela Research Laboratory,
Nela Park, Cleveland, Ohio.

Air Required in Baking Cores Made With Linseed Oil

To the Editor of Chemical & Metallurgical Engineering

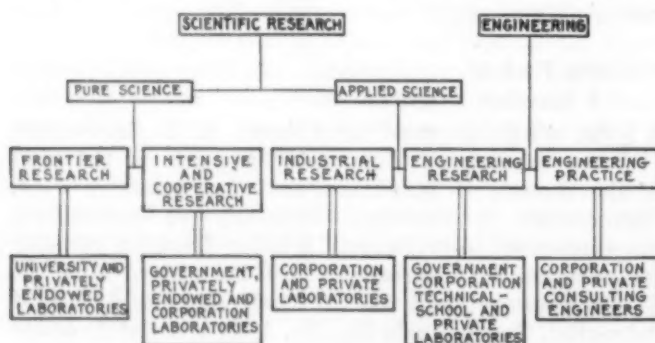
SIR:—In reading an article published in your issue of Oct. 26, 1921, on "Air Required in Baking Cores Made With Linseed Oil," by A. A. Grubb and U. S. Jamison, I note in the early part of the article a discussion of the amount of oxygen absorbed by linseed oil in drying, as well as the amount of hydrogen and carbon given off in the form of water and carbon dioxide.

The results of two investigations by Cloez and A. Genthe were quoted. Both of these authors had determined the increase in weight of the linseed oil, while Cloez had also determined the chemical composition of the linseed oil and the dry oil. Messrs. Grubb and Jamison draw conclusions from these results as to the total amount of oxygen which had been absorbed and the amount of carbon dioxide and water which had been given off.

Your authors apparently had overlooked the publication by myself and A. E. Ratner on this subject. The published report was entitled "The Decomposition of Linseed Oil During Drying" and was published in the report of the Eighth International Congress of Applied Chemistry, vol. 12, page 165.

An examination of this article will show that Mr. Ratner and myself in carrying out this investigation not only weighed the linseed oil before and after drying but also absorbed the carbon dioxide and water which were given off. We found that the oil, after 74 days, had increased 18.05 per cent in weight, while 14.55 per cent of water and 5.21 per cent of carbon dioxide had been given off. These figures show that 37.8 per cent of oxygen had been absorbed. These percentages were calculated on the weight of the linseed oil.

On comparison with the figures quoted by Grubb and Jamison, it will be noted that they find a much larger percentage of carbon having been given off and a much smaller percentage of hydrogen than are shown by our



CLASSIFICATION OF RESEARCH ACTIVITIES

figures. The calculation of the results published by Ratner and myself indicate that 1.42 per cent of the carbon was given off as carbon dioxide and 1.62 per cent of the hydrogen, calculated on the weight of the linseed oil. This is equivalent to 1.87 per cent of the carbon present in the oil and 14.73 per cent of the hydrogen. It may readily be that in the results given by Cloez the carbon percentage of the original oil was somewhat high, while the carbon percentage of the dried oil, as obtained by the analysis, may be low, the opposite being true of the hydrogen analysis. Unless the ultimate analysis was carried out with the greatest of care, there may be considerable error in the carbon and hydrogen determinations. On the other hand, the absorption of carbon dioxide and water as given off in the drying of linseed oil can be carried out with great accuracy. It also seems more reasonable that the hydrogen should be given off in larger quantity than the carbon in the drying of a substance like linseed oil.

Polytechnic Institute,
Brooklyn, N. Y.

J. C. OLSEN,
Professor Chemical Engineering.

Facts and Fancies About the Oppau Explosion

To the Editor of Chemical & Metallurgical Engineering

SIR:—In recent issues of your journal, and in particular on pages 814-815 and 818-822 of the Nov. 2 issue, many different explanations of the recent disaster at Oppau have been discussed, and it has been concluded that no theory yet advanced can be regarded as more than speculative. The cause of the sudden decomposition of the 4,500 tons of ammonium sulphonitrate ($(\text{NH}_4)_2\text{SO}_4 \cdot \text{NH}_4\text{NO}_3$) remains a mystery.

So far only chemical explanations have been adduced. It is very possible, however, as will be evident from what follows, that the primary cause of the explosion may have been of a purely physical nature.

Ammonium nitrate is a salt which exists in no fewer than six different crystalline modifications.¹ Five of these are stable at atmospheric pressure, each throughout a definite temperature interval only. The various transition points have been very carefully investigated², and it has been found that changes in crystal form, as the substance cools, occur at 125.2, 84.2, 32.1 and —18 deg. C. Each transformation is attended by considerable evolution of heat and by a considerable change in volume, in some cases positive (expansion) and in others negative (contraction).

The study of these transition points became a matter of practical importance during the Great War, when ammonium nitrate, mixed with TNT to give amatol, was used very extensively as a high explosive. Any change of state involving an increase in volume which might occur in a filled and sealed shell would, it is clear, constitute a grave source of danger, owing to the inevitable rupture of the shell. The time-honored experiment of bursting a bomb by filling it with water, screwing the fuse tight and leaving it out of doors on a cold winter night may be mentioned as a familiar, exactly analogous phenomenon.

Now the change of state which is most significant in the case of stores of ammonium nitrate is that which occurs at 32.1 deg. C. (89.8 deg. F.), since this temperature will very frequently be exceeded in summer. The transformation brought about by raising the temperature above 32.1 deg. C. resembles that induced by cooling water below 0 deg. in two respects—it is very

subject to delay and it is accompanied by a large increase in volume. The presence of other substances accentuates the tendency toward delayed transformation; it is quite possible to raise ammonium nitrate mixture to a temperature well above 32.1 deg. C. without immediate change of state occurring, just as it is possible to supercool water solutions without immediate appearance of ice. In such an event, however, the system will be like a cocked gun. Any disturbance of the metastable conditions will start a rapid change of state.

Is it not plausible that this is what took place at Oppau on the morning of Sept. 21? We are told that the temperature in the storehouse during the previous night was over 100 deg. F. Suppose transformation to have been delayed, and to begin suddenly at some point in the caked mass of ammonium sulphonitrate at such a temperature. It would spread rapidly through the entire 4,500 tons. The consequence would be a great increase in the volume of the material. At many places in the interior of the hard, rocky mass, tremendous pressures would be set up, which could be relieved only by explosive disintegration. This preliminary physical explosion might very conceivably be severe enough to induce a secondary chemical explosion throughout the entire mass, playing the part of the primer in the detonation of a high-explosive shell.

All this is, of course, like the other theories which have been put forward, merely speculative, but it constitutes a possibility which ought not to be left out of consideration. One of the first points for investigation should be the exact effect of ammonium sulphate (with which ammonium nitrate forms at 30 deg. two double salts, both unstable in water solution³) upon the transitions of ammonium nitrate. It is quite likely that the double salts formed also exist in more than one allotropic modification. As you have aptly stated in your editorial of Nov. 2, "an intensive study of the nature of ammonium nitrate and its mixtures may not explain all of the mysteries of the Oppau explosion, but it will do much to prevent the recurrence of similar disasters."

Chemistry Department,
Columbia University,
New York City.

JAMES KENDALL.

Explosion of Agitator Charged With Naphtha

To the Editor of Chemical & Metallurgical Engineering

SIR:—At a neighboring refinery an agitator charged with 50 deg. Bé. naphtha exploded recently without any apparent cause. The explosion occurred almost immediately after the agitator had been charged with approximately 900 bbl. of the naphtha. This oil had a temperature of about 70 deg. F. and was pumped up from the bottom through the chemicals, which consisted of litharge and caustic soda. The agitator has a capacity of about 2,100 bbl. and is not lead-lined. Electric light wiring was carried in conduit and it seems unlikely that a spark from this source may have been the cause. It is said a street car about 100 yd. distant passed by at the time of explosion, and, by a spark, may have ignited the light vapors which were carried in that direction. No strong wind prevailed at this time.

Will you please inquire if some of your readers or contributors can give a cause for this fire?

W. H. PAPE,
Tulsa, Okla. Mechanical Supt., Cosden & Co.

EDITOR'S NOTE: We invite discussion of this subject and shall be glad to publish pertinent comments.

¹Bridgman, *Proceedings, American Academy of Arts and Sciences*, 1916, vol. 51, p. 605.

²Early and Lowry, *J. Chem. Soc.*, 1919, vol. 115, p. 1387.

³Roozeboom, *Heterogene Gleichgewichte*, 1911, vol. 3, Part 1, p. 138.

American Iron and Steel Institute

Varied Program of Technical Papers at the Twentieth General Meeting Included Furnace Design, Firebrick, a Direct Process for Steel Manufacture, Welding, Relation of Iron and Steel Industry to the Chemical Industry, and Steel Lumber

LAST Friday, Nov. 18, the American Iron and Steel Institute met for its twentieth general meeting in New York City, and was proud to entertain Marshal Foch. Over a year ago, when President Gary was in Paris, Marshal Foch expressed the desire to meet a representative gathering of men in the American steel industry. And so the steelmakers put on their holiday togs and forgot their business worries long enough to do honor to the leader of the allied armies.

The result was the largest banquet New York has ever seen—and who will say that men in the steel industry do not enjoy big things?—largest in point of numbers, and second to none in a genuinely enthusiastic and whole-hearted welcome to an admired friend. President Gary, William D. Guthrie and Charles M. Schwab ably expressed the sentiments of the assembled members and the industry they represent toward their honored guests. Mr. Schwab's talk was especially interesting, since it was the first public comment since the Disarmament Conference by the genial head of the greatest munition plant of the world, and he echoed the thoughts voiced by Mr. Gary in the morning.

"I would like to take advantage of this occasion to say something which has long been upon my heart, and which at this significant moment it is clearly my duty to say," said Mr. Schwab. "It was stated at some of the sessions of the recent League of Nations at Geneva, it has often been carelessly suggested in the press, that the flame of war is in great measure kept alive by those interested in the private building of naval ships and the manufacture of munitions of war.

"I can, of course, speak only for myself, but I believe I know and express the sentiments of others placed in positions similar to mine when I say this:

"If the armed protection of our country is necessary, the establishment of which I am the head will devote itself with all its energy to providing means for the protection of this country's homes and families. But I say to you from the bottom of my heart that if the statesmen now assembled in Washington, under the far-sighted leadership of our President and Secretary Hughes, should find it possible to bring about disarmament and permanent peace, gladly would I see the war-making machinery of the Bethlehem Steel Corporation sunk to the bottom of the ocean."

Morning Session

Judge Gary, as is the custom, opened the morning session with an address—not before the members had tendered him a hearty welcome, almost an ovation. After calling attention to statistics showing a steady improvement in American business during the autumn months, he warned his audience that it was yet impossible to predict when the world, or even this country, would return to normalcy. This he felt was due to high cost of living, the high cost of production and transportation and the high cost of earning and owning money, costs which were inflated for a variety of reasons, but which must be adjusted more nearly to their mutual

relations before the war. Judge Gary was inclined to blame the high cost of living largely to grasping middlemen handling food, clothing and shelter. Production and transportation costs were controlled by inflated labor rates and low performance in highly unionized trades. Lastly, taxes were so high that there was little incentive for the owner of money or property to put it to use and further extend his holdings. When these conditions would be corrected, he could not prophesy.

Enthusiastic applause marked his assertion that the industry confidently expected a sharp limitation of naval armament. Considerations as to tonnage lost to the steel industry were unworthy of notice. As a matter of fact, what could be better for business—either in steel or paper, wheat or textiles—than a world at peace?

TECHNICAL PAPERS

S. W. Miller, president of the American Welding Society, opened the technical session with an extensive paper on Fusion Welding. He discussed in detail the effects of oxygen and oxide in welds and in the plates to be welded—a matter which we hope to present in extenso later. The following properties of recommended metal should be interesting:

TABLE I. PROPERTIES OF WELDING MATERIALS

	Steel to Be Welded	Gas Welding Usual Welding Rod	Gas Welding Preferred Welding Rod ¹	Electric Welding Hard Drawn Rod ²
C.....	0.15 (max.)	0.06 to 0.10	0.20	0.15 to 0.18
Mn.....	0.30 to 0.60	0.15	0.40 to 0.60	0.40 to 0.60
S (max.).....	0.05	0.03	0.04	0.04
P (max.).....	0.04	0.03	0.04	0.04
Ni.....			3.25 to 3.75	
Tensile strength	50,000	52,000 (max.) ²	58,000 ²	60,000 ² (max.)
Yield point	30,000			
Elongation in 8 in., per cent, 30				
¹ Corresponds to S.A.E., specification 2320.				
² Strength of weld.				
³ Chemical analysis not so important as hardness, uniformity and high general quality.				

In order that tests may be of value, they should be executed on fairly large specimens and show the following data:

Chemical analysis of the wire. Chemical analysis of the base metal. Tensile strength and other characteristics of the base metal. Microstructure of the base metal. Microstructure of the welding wire or electrode. Tensile characteristics of the welded pieces. Bending characteristics of the welded pieces, hot and cold. Size of electrode or welding wire. Amount of wire used. Amperes during welding. Open circuit voltage. Welding voltage. Make of torch and size of tip. Gage pressure of oxygen and acetylene.

A cold bend test is extremely informative. Take a single V flush weld about 2 in. long, and bend it so the top of the V is stretched, measure the angle at fracture, and note what portion of the bend occurred in the weld and what portion in the plate.

WELDING OF CAST IRON

The welding of cast iron is easier than that of any other metal, and the results obtained are better, except possibly in case of cast aluminum, where the results are just as good. In welding cast iron any material

that is to be added should be of such a character that the application of heat will not burn out the carbon and silicon to such an extent as to make the weld difficult to machine. This means that it should contain a considerable proportion of silicon, this being the first constituent to disappear under the heat. Ordinary machine iron is entirely unsuitable for the purpose, and it is usual for a good cast-iron welding rod to contain at least 3 per cent of silicon. When this metal is melted into the weld, it produces a fine-grained structure lower in graphitic carbon than the material being welded, because it is applied in small quantities and cools rapidly. In gas welding of cast iron it is permissible to use a tip that is large in proportion to the size of the casting, blocking up the edges to keep the melted metal from running away. But in steel welding by gas, too large a tip will make the metal boil and foam, and is certain to injure the weld. A properly welded piece of cast iron will always break outside the weld. The principal difficulty in cast-iron welding is in taking care of the shrinkage or contraction, which of course cannot be avoided, although it can usually be allowed for by expanding other parts of the piece, or by setting the pieces farther apart than they were when broken. The proper methods to follow to avoid strain in the welded piece, due to expansion and contraction, require close attention and much experience on the part of the welder; and even with the greatest care cracks occur at times. It is quite possible that there will be heavy strain in the welded piece, which, however, will not be great enough to cause trouble until it is put in service, when the additional strain due to this may cause it to break. Chilled iron is readily welded, although, on account of its brittleness, the difficulties from expansion and contraction strains are increased when compared with gray iron. Malleable castings dare not be melted, and therefore are not capable of being welded, unless they can be annealed, which is usually impossible. It is therefore customary to join broken parts of malleable iron by using a manganese brass or a similar alloy, which will unite with the malleable iron at a temperature below its melting point. The joint so made is strong and ductile and answers every purpose. Of course, if the malleable iron be melted, it will revert to chilled iron and lose its strength and ductility. Even the use of manganese brass will to some extent change these properties, but not sufficiently to cause trouble in practice.

DIRECT PROCESS FOR STEEL MANUFACTURE

An interesting paper discussing a "Direct Process for Steel Manufacture" was presented by O. E. Bourcoud. After a brief review of the many previous and unsuccessful attempts, he says that solution of the problem depends upon, first, a method of producing large volumes of hot reducing gas of great purity from low-grade fuels (a matter discussed by him at length in *CHEMICAL & METALLURGICAL ENGINEERING*, April 6, 1921, under the title "Gasification of Powdered Coal"), and second, correct application of a stream of this gas to the ore to be reduced. The essential conditions surrounding the latter may be defined by a study of blast-furnace operations, which Mr. Bourcoud presents in a very interesting manner, showing that his resulting mathematical formulas for the reduction of hematite apply equally well to the 80-ton furnace described many years ago by Sir Lowthian Bell, and to the modern 500-ton Lackawanna furnace studied by H. H. Campbell. His formula shows that the time required to reduce a

spherical lump of ore to a given depth varies directly as the square of that depth, inversely as the percentage of reducing compounds in the gas and inversely as the square root of its velocity head. Using gas containing 45 per cent of active elements at an average temperature of 850 deg. C. and at a velocity of 9.1 m. per second, 480 seconds would be required to reduce an ore particle 1 mm. in diameter. If the particle be smelted in a rotary furnace and lie on top the charge 42 seconds in every hour, the ore would need to remain in the furnace 11.7 hours, and a 10-ton per hour furnace would need to be nearly 1,000 ft. long.

In order to reduce this evidently impracticable size, the author proposes to introduce spiral baffles in a 10-ft. rotary furnace, with a pitch of 2 m. forcing the gas to spin through in a whirlwind fashion, thus increasing the pressure head and increasing the amount of active gas from 7 per cent to 55 per cent of the total in the furnace. In such a furnace passing 62 cu.m. of gas per second at 850 deg. C., the mean velocity of gas in contact with the ore would be 33.9 m. per second, the angle of impact about 63 deg., and the normal pressure about 4 kg. per square meter. A grain of ore 3.4 mm. in diameter would be reduced in 140 seconds, and a 10-ton per hour furnace would be 75 m., or 250 ft., long.

The paper concludes with plans and estimates of a complete plant, consisting of proper gas producers, pre-heating (and nodulizing) furnaces, reduction furnaces, machines for compressing the hot sponge out of contact with air and charging directly into electric furnaces, where the metallic iron is melted and separated from any unreduced oxides, the latter forming a slag. Extensive tables showing the thermal balance and estimated (pre-war) costs of the operation are also appended.

J. M. Camp, director of the bureau of technical instruction, Carnegie Steel Co., then read a paper on the "Relations of the Iron and Steel Industries and the Chemical Industries," a paper which we shall print in a subsequent issue.

Afternoon Session

W. A. Hull, of the Bureau of Standards, recounted the work which has been done at that institution, at the Mellon Institute, and by leading refractory manufacturers, on the properties of firebricks. During the last 20 years various tests have been devised and reduced to a workable basis. However, there is still a great need of information on the actual conditions of service, information which the consumer should have in order to purchase his firebrick intelligently. It follows that specifications are largely influenced by the brick manufacturers, who describe in them something they can make cheaply and in quantity, whereas the specification should often call for something ideal for the purchaser, but at first little more than a mark for the producer to aim at.

"The question of price is one of the big stumbling blocks in the way of improvement. Not until the information gained by the production man and the metallurgist penetrates to the purchasing agent's sanctum in sufficient quantities to produce an effect can the refractories question be said to be on a fair way to a satisfactory solution."

Therefore, notwithstanding serious complaints by prominent metallurgists, Mr. Hull is of the opinion that the average product is unquestionably better than it

was 20 years ago. The eyes of the users have been opened to the fact that even the best brands do not run as uniform as they had been assumed to do, and defects that had formerly been counted of small consequence have been found to be vital factors in shortening the life of important installations. Some large metallurgical establishments are now making some of their own refractories, because their own efforts give vastly better results in special service than anything they are able to buy. American brick for byproduct coke ovens, and the recent successful application of silica refractories to limekilns and beehive ovens, are two achievements which indicate that firebrick makers can deliver an excellent product in large quantity when they have acquired the necessary information on what duty the brick must withstand.

OPEN-HEARTH PORTS

"Improvements in Port Construction in Open-Hearth Steel Furnaces" was discussed in a paper by John W. Kagarise, of the Edgar Thomson Works. Owing to the fact that flame temperatures are perilously near the softening point of furnace refractories, the shape and contour of the passages through the "block" were either built to oppose minimum resistance to the rush of hot gases, or the flame rapidly rendered them so. Only since the advent of successful water-cooling devices has it been possible to build ports on rational lines with reasonable assurance of permanence.

Experiments were made at the South Chicago Works in 1903, using a series of 1-in. pipes, one behind another reaching from front to back of furnace and bent so as to cool the two sides and top of the gas port mouth. By this means a life of 300 to 400 heats is now obtained. Clear water is not available in the Pittsburgh district, so the Duquesne plant developed the so-called Parks port. In this, the gas port arch is laid of 9-in. brick; then eleven 4-in. water pipes are laid side by side, and the arch finished by a 4½-in. brick cover. The water pipes reach from outside the block to within a foot of the mouth; a 1-in. pipe inside each discharges cooling water near the welded end. In case one of the pipes becomes plugged or is lost, it can easily be withdrawn and a new one inserted; 300 to 400 heats are obtained.

Welded steel plate water jackets have been successfully exploited by L. L. Knox, recent designs of the cross-port cooler extending from front to back of the furnace near the front of the port, and thus is very accessible when it is necessary to clean out sediment. The Lackawanna Steel Co. uses a so-called Blair port, which is a trough-like water jacket, which when inverted and properly set forms the complete side walls and arch of the gas port. Some early forms have been in use 6 years.

While operators now readily agree that some form of water cooling is indispensable, only recently have they turned their attention to a principle stated in 1912 by C. A. McCollum of the Homestead works: that well-mixed air and fuel should enter the furnace at high velocity through constricted openings, and waste gas leave at low speed through wide flues. In order to effect this, the Steel Co. of Canada has adopted the McKune system, and the Brier Hill Steel Co. the Egler furnace. Both these designs close the air uptakes on the incoming side with water-cooled valves. Air is blown through the checker chambers into a well and from there through the central port. Gas also enters the central port

through appropriate openings, and the mixture burns at the mouth much like a blow torch. At South Chicago, constriction at the incoming end is more simply effected by lowering water-cooled dampers through the roof, directly in front of the air ports, partially closing them and forcing the air to enter at the center of the furnace, cutting across the gas current. Such a furnace has made 106 heats each of 85.5 tons in a month, working on regular orders of steel ranging from 0.08 to 0.45 carbon. Charge was 53 per cent hot metal, 41 per cent scrap and 6 per cent ore. Coal consumed per ton was 348 lb. of 13,200 B.t.u. Kentucky coal.

"Venturi Line" furnaces have also been developed at South Chicago, so called from the fact that the arch above the ports dips sharply toward the bath, and the side walls also bulge inward, thus giving internal lines roughly like a Venturi meter. These restricted openings, a gas port mouth set back about 3 ft. from the neck, and induced draft from a waste heat boiler installation have given thorough mixing of air and fuel and good flame control. Combined with side dampers, this type of furnace gave the remarkable tonnage noted.

Various modifications of these systems are necessary when the fuel is changed from producer gas to natural gas, to pulverized coal, to byproduct oven gas, or to tar. Byproduct gas has given some trouble owing to its non-luminous flame; tar has been introduced to cure this defect, but it has been found at Duquesne that if a small quantity of air be burned in the gas as it enters the furnace, the luminosity of the flame can be controlled at will.

Conditions in Swedish Iron Industry

Reports submitted at a recent meeting of the Swedish Iron Works Association show that during the second quarter of this year but twenty of the 134 blast furnaces have been running, and only a few of the steel plants have been kept going on very short time, reports Consul General Murphy of Stockholm in *Commerce Reports*.

SIX MONTHS' IMPORTS AND EXPORTS OF IRON AND STEEL

January-June	Exports Tons	Imports Tons	January-June	Exports Tons	Imports Tons
1914.....	189,500	137,200	1918.....	200,300	51,400
1915.....	238,600	103,500	1919.....	129,600	33,700
1916.....	276,000	163,300	1920.....	134,400	110,300
1917.....	244,500	43,500	1921.....	61,300	71,300

In the first seven months of 1920 the export of iron ore amounted to 1,900,000 tons, while the export for the corresponding period of the present year amounted to 2,560,000 tons—an increase of 660,000 tons.

At the end of July, 1920, out of the 131 blast furnaces in Sweden, but 66 were running and of the 203 Lancashire hearths but 84 were operating. At the time mentioned there were likewise but 12 of the 18 bessemer, 41 of the 77 Martin furnaces, 4 of the 20 electrical steel furnaces partially in operation. At the end of July of this year the situation was still worse—i.e., 20 blast furnaces, 49 Lancashire hearths, 6 bessemer, 17 Martin and 5 electrical steel furnaces were running.

The production of pig iron in the first seven months of this year amounted to 225,600 tons, against 249,500 tons in the corresponding period of last year; blooms, 13,800 tons, against 31,300 tons; bessemer ingots 15,400 tons, against 26,600 tons; and Martin ingots, 96,500 tons, against 200,600 tons in January-July of 1920. rolled and forged iron and steel were manufactured to the extent of 63,600 tons, against 173,400 tons.

Sulphate-Free Sulphites for Standard Sulphur Dioxide Solutions

BY S. LANTZ SHENEFIELD, FRANK C. VILBRANDT AND
JAMES R. WITHROW

THIS paper points out: (1) The doubtful validity of all previous work based on the use of sodium sulphite as a standard in sulphur dioxide investigations; (2) the inability to prepare sodium sulphite free from sulphate according to manipulation details in the literature; (3) the difficulties encountered in preparing pure moist sodium and calcium sulphites and their subsequent oxidation during drying.

The question of SO₂ fumes from chemical as well as smelter plants is of constant interest. Simplification of the methods for SO₂ determination naturally demands attention. Important and acceptable as the iodine method for the determination of SO₂ may be, there has always been a demand for an alternative method, and, if possible, one based on a more stable standard titrating solution. The use of potassium permanganate has been investigated repeatedly for this reason. This laboratory became interested in this latter method to reduce the cumbersomeness of the field test when the iodine method is used.

UNRELIABILITY OF SODIUM SULPHATE AS STANDARD

In any important investigation it is fundamentally desirable, if possible, to use as a standard the actual material to be investigated, if the latter can be got into condition of known concentration. In the analytical study on pollution of the atmosphere by fumes from smelters many chemists have encountered great difficulty in the evaluation of methods of determining the SO₂ content because they have accepted statements in the literature with respect to the reliability of sodium sulphite as a standard in the study of SO₂ pollution. The danger from accepting such statements is not always realized, thereby leading to erroneous conclusions regarding certain analytical methods of evaluating SO₂, sulphurous acid or sulphites.

This work endeavors to prove the unreliability of accepting sodium sulphite as such a standard. It is shown how far the preparation of sulphate-free sulphite can be accomplished when the product is recrystallized or dried, and also the possibility of obtaining such a product in the freshly prepared moist condition.

The use of sulphites for standardizing permanganate solutions would eliminate a host of troubles which occur in the analysis of a mixture of gases containing a water-soluble component such as sulphur dioxide. Quite naturally, therefore, sulphites have been used by previous workers for standardization in the comparison of the permanganate and iodine methods [Lunge and Smith, *J. Soc. Chem. Ind.*, vol. 2, p. 460 (1883); Lunge and Segaller, *ibid.*, vol. 19, p. 222 (1900); Pinnow, *Z. anal. Chem.*, vol. 43, p. 91 (1904); and Millbauer, *Z. anal. Chem.*, vol. 48, p. 17 (1909)], and also directly as a standard in iodimetry [Giles and Shearer, *J. Soc. Chem. Ind.*, vol. 3, p. 197 (1884); Volhard, *Ann.*, vol. 242, p. 101 (1887); Richardson and Aykroyd, *J. Soc. Chem. Ind.*, vol. 15, p. 172 (1896); and Ferguson, *J. Amer. Chem. Soc.*, vol. 39, p. 364 (1917)] and for testing the applicability of the permanganate method [Honig and Zatzek, *Monatsh.*, vol. 4, p. 738 (1895); Dymond and Hughes, *J. Chem. Soc.*, vol. 71, p. 314 (1897); and Sweeney, Outcalt and Withrow, *J. Ind. Eng.*

Chem., vol. 9, p. 949 (1917)]¹ for sulphur dioxide, sulphurous acid and sulphite determinations.

In continuing an investigation started in this laboratory on sulphur dioxide fume from sulphuric acid plants, irregularities of unknown origin were found in a previously published paper on the subject from this laboratory (Sweeney, Outcalt and Withrow, *loc. cit.*). An effort had been made therein to use sodium sulphite as a standard of known concentration of SO₂. Preliminary gravimetric analyses of this substance disclosed variable sulphite composition and the constant presence of sulphates by qualitative tests with barium chloride in acid solution. It was then found in a review of the literature that in all cases therein where sulphate-free sulphites were claimed to have been prepared mention is omitted of any qualitative test used to demonstrate this. It seems to have been assumed that recrystallization eliminated the sulphates. This raises grave doubts as to the validity of all previous work on the use of sulphites as standards, except in those cases where rigorous quantitative examination was frequently made upon the sulphite. We have therefore undertaken the preparation of sulphate-free sulphites to determine the actual occurrence of sulphate contamination with various preparation precautions.

OXIDATION OF SODIUM SULPHITE

The oxidation, upon standing, of Na₂SO₃ in the hydrated and anhydrous forms and in solution has been a matter of debate in the literature. It is claimed by some that it is stable under one or another of these conditions while others claim to have proved its instability [Davies, *J. Soc. Chem. Ind.*, vol. 1, p. 88 (1882); Giles and Shearer, *loc. cit.*; Reese, *Chem. News*, vol. 50, p. 219 (1884); Bothamley, *Am. J. Pharm.*, vol. 62, p. 520 (1890); Bigelow, *Z. phys. Chem.*, vol. 26, p. 493 (1898); Griffin, *J. Soc. Chem. Ind.*, vol. 19, p. 321 (1900); Young, *J. Amer. Chem. Soc.*, vol. 24, p. 314 (1902); Pinnow, *loc. cit.*; Lumiere and Seyewitz, *Z. angew. Chem.*, p. 784 (1904); Kastle and Elvolve, *J. Inf. Dis.*, vol. 6, p. 619 (1909); Hartley and Barret, *J. Chem. Soc.*, vol. 95, Tr., p. 1178 (1909); Elvolve, *Am. J. Pharm.*, vol. 82, p. 211 (1910); Foerster, *Arbb. Kais. Gesundh. Amt.*, vol. 49, p. 468 (1914); *Centralb.*, 1915, i, p. 447, and Haller, *J. Soc. Chem. Ind.*, vol. 38, p. 54 (1919)].

The irregularities of the reaction of KMnO₄ solutions on sulphites when the percentage recovery of SO₂ is found by the KMnO₄ method has been studied by Honig and Zatzek (*loc. cit.*, p. 746); Raschig [*Z. angew. Chem.* (1904) p. 580]; Pinnow [*loc. cit.*]; Day and Baker [*Analyst*, vol. 37, p. 439 (1912)], and Craig [*J. Soc. Chem. Ind.*, vol. 38, p. 96 (1919)].

The need for stabilization of sulphite solutions is also keenly recognized in the medical profession. The conclusions obtained in this field by various workers is that organic bodies in general are inhibitors of oxidation of sulphite solutions. [Foerscher, *J. Prakt. Chem.*, vol. 37, p. 27 (1846); Bigelow, *loc. cit.*; Young, *loc. cit.*; Titoff, *Z. phys. Chem.*, vol. 45, p. 641 (1904); Ruff and Jeroch, *Ber.*, vol. 48, p. 499 (1905); Baker and Day, *J. Soc. Chem. Ind.*, vol. 31, p. 1048

¹Correction—The former article on SO₂ by Sweeney, Outcalt and Withrow (*loc. cit.*) from this laboratory credits the Selby Smelter Commission (U. S. Bureau of Mines Bull. 98 and Dymond and Hughes, *loc. cit.*) with using sodium sulphite as a basis for standardization and study. A subsequent correction [*J. Ind. Eng. Chem.*, vol. 9, p. 1148 (1917)] requests omission of this statement. Nevertheless, Dymond and Hughes actually depended on Na₂SO₃ as such a basis, though the Selby Smelter Commission did not do so.

(1912); Pinnow, *loc. cit.*; Sauillard, *Compt. rend.*, vol. 160, p. 318 (1915); Matthews and Weeks, *J. Am. Chem. Soc.*, vol. 39, p. 635 (1917); and Haller, *loc. cit.*] A general review of the literature on the substitution of other sulphites for the sodium salt reveals the fact that other sulphites are equally or more difficult to prepare pure. [Seuber and Elton, *Z. anorg. Chem.*, vol. 4, p. 44 (1893); Demmer, *Das Chemische Technologie*, vol. 1, p. 116 (1895); Griffin, *loc. cit.*; Weston and Jeffries, *Chem. News*, vol. 97, p. 85 (1908); Alexander, *Z. anal. Chem.*, vol. 48, p. 31 (1909); Henderson and Weiser, *J. Am. Chem. Soc.*, vol. 35, p. 239 (1913), and Abegg, *Handbuch der Anorganische Chemie* (1908).]

Whenever we attempted to use commercial sodium sulphite, unsatisfactory results were obtained in spite of all precautionary measures, and purification methods, such as the use of air-free water, repeated crystallization and centrifuging. The synthetic preparation of sodium sulphite was therefore undertaken. After unsatisfactory efforts with SO_2 and NaOH , carrying on all the operations in the absence of air, Na_2CO_3 was used. The apparatus consisted of a train for washing SO_2 from a cylinder through FeSO_4 solution for absorbing any oxidizing gases, BaCl_2 in HCl solution for precipitating any sulphates, water for absorption of spray from the previous wash bottles, saturated Na_2CO_3 solution for sulphite preparation and a Na_2CO_3 trap solution to prevent back suction of air into apparatus or the escape of SO_2 into the air.

The water and sodium carbonate solutions used were both sulphate and air free. After absorption of SO_2 in the Na_2CO_3 solution to form NaHSO_3 , an equivalent amount of Na_2CO_3 in solution was added and the evolved CO_2 was swept out with pure N_2 from a gasometer after passing through alkaline pyrogallate. The solution was then cooled to 0 deg. C. The fine crystal meal separating was filtered without removal from the apparatus by technique similar to that used by Hartley and Barret (*loc. cit.*)

For drying the hepta-hydrate a modification of the customary two-piece desiccator was used. The drying agent was 96 per cent H_2SO_4 and sodium pyrogallate solution was the oxygen absorbent.

RESULTS

The damp $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ upon being put in the desiccator gave not the slightest test for sulphates with BaCl_2 . The same was true of the mother liquor taken from the salt. In spite of the precautionary measures taken to prevent oxidation or leakage of air into the apparatus, some oxidation did subsequently take place; after one week of standing the product analyzed 7.52 per cent $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ and 88.7 per cent $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ with about 3.78 per cent excess moisture. The quantity of surface exposed on crystals of sodium sulphite is naturally enormously great compared with a solution of the salt, so that one naturally expects a more ready oxidation on moist crystals than one would in a concentrated solution which Lumiere and Seyewitz (*loc. cit.*) claim is stable.

An investigation was started to see if any other sulphite could be prepared in a more stable form. Calcium sulphite can be used as readily as sodium sulphite as a gravimetric standard for SO_2 . Since calcium sulphite is about forty-six times as insoluble as calcium sulphate at 18 deg. C., it was believed that any sulphate present in calcium sulphite could be readily washed out. This

was attempted and proved to be the case, for no sulphates were present on the wet or moist product. This fact also indicates that since sulphates were originally present and could be washed out, the sulphate contamination was not due to adsorption. Precautionary measures used in drying proved of no avail, for in all cases the dry sulphite was contaminated with sulphates produced by oxidation during the drying. It was felt, therefore, that calcium sulphite preparation offered no advantages over sodium sulphite.

ORIGIN OF THE SULPHATE CONTAMINATION

The sulphate found by the qualitative test with BaCl_2 resulted undoubtedly from oxidation of the sulphite. Such oxidation could occur in one of two ways. It might have resulted from leakage of air into the apparatus or from auto-oxidation of the sulphites themselves. In this work the apparatus, method and precautions used to exclude air leakage during preparation and drying were all that possibly could be expected.

It seems clear therefore that the preparation of sulphate-free sulphites for standard sulphur dioxide solutions is so difficult (if not impossible) that all work heretofore based upon such use of sulphites is of questionable validity.

While unsuspected air leakage could always be a possibility, nevertheless the precautions taken forced the conclusion that some form of auto-oxidation was really responsible for the sulphate contamination. Some of the sodium sulphite could conceivably oxidize other portions, being itself reduced to various possible derivatives, for Jungfleisch and Brunel [*Compt. rend.*, vol. 156, p. 1719 (1913)] have shown that $3\text{SO}_2 + 2\text{H}_2\text{O} \rightarrow \text{S} + 2\text{H}_2\text{SO}_4$. As our object was an effort to confirm, if possible, the literature claims that a sulphate-free sulphite was readily preparable, we did not stop at this time to investigate the interesting and complicated fields which, it is well known, auto-oxidation presents among the sulphur acids.

A sample of dry $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$, chemically pure, was tested for stability and showed an increasing amount of oxidation on standing. From an initial analysis of 89.61 per cent $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ by gravimetric analysis, it dropped to an average of 68.5 per cent two months later. Therefore the use of sodium sulphite hepta-hydrate as a weighable gravimetric standard in itself appears to be wholly unsatisfactory in refined work because of the necessity of its frequent analysis. To investigate the influence of manipulation details on the variation errors, a study was made of the influence of time of standing in solution before completion of the analysis. It was found that when air-free water was used for dissolving the sodium sulphite the purity of $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ as determined by the iodine method dropped from 88.5 per cent when solution stood 5 minutes before completion of analysis to 87.2 per cent after a 15-minute period and to 84.6 per cent when the solution was allowed to stand 40 minutes. In each of the above cases HCl was added to the iodine solution so that any oxidation that took place occurred within the Na_2SO_3 solution and the difference was not due to loss of SO_2 on standing as an acidified sulphite solution. This demonstrates that dilute Na_2SO_3 solutions are unstable in the presence of air, the extent of oxidation being a function of the time the solutions were in contact with the air.

The conclusions reached are:

1. All statements in the literature concerning the

preparation of sulphate-free sodium sulphite should be seriously questioned.

2. The validity of all investigations in the literature based upon the use of the prepared sodium sulphite as a sulphur dioxide standard is doubtful.

3. The inability to prepare sulphate-free sulphite for use as an SO_2 standard solution according to directions given in the literature has been shown.

4. Due to the rapid oxidation of sodium sulphite solutions in the presence of air, if for no other reason, this use of the substance for standardization of oxidation solutions is objectionable.

5. No method tried by us gave a dry $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ free of SO_2 when tested by BaCl_2 and HCl , notwithstanding claims in the literature that "pure sulphites" or " SO_2 -free sulphite" could be prepared.

6. A sulphate-free sodium sulphite heptahydrate and also calcium sulphite can be prepared moist.

7. Drying of sodium sulphite and calcium sulphite contaminated the product by oxidation.

8. This sulphate contamination is not due to adsorption of sulphates on sulphite.

9. Moist sulphites, all sodium sulphite solutions, and particularly dilute solutions, oxidize rapidly in air.

10. A recrystallization process, if carried on in the presence of air, will not give a sulphate-free product on account of this rapid oxidation.

11. Dry $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$ is not stable toward oxidation in the air.

12. The production of sulphate-free calcium sulphite presents the same difficulties as does sodium sulphite.

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Concentrated HCl as Metallographic Etching Reagent for Nickel

BY HENRY S. RAWDON* AND MARJORIE G. LORENTZ*

NICKEL and the nickel-rich alloys are usually classed among the best of the non-corrodible materials in common industrial use. Since they are so inactive chemically, they are etched for microstructural examinations with very considerable difficulty as a rule. Very active reagents, such as nitric acid or an acid to which a strong oxidizing agent has been added, are required. When etched with such solutions, pitting of the surface is apt to be excessive, and this is often the most conspicuous feature of the microstructure revealed. Another point, which is usually a disadvantage, is the plain etch-pattern produced lacking in contrast. Only the grain boundaries are revealed and none of the grains has any "individuality."

It is the purpose of this note briefly to refer to the use of concentrated hydrochloric acid as a metallographic etching reagent for nickel as having some very desirable features which most of the other reagents lack. The use of concentrated hydrochloric acid for this purpose was developed during the general study of etching reagents now in progress at the Bureau of Standards.¹

In the accompanying micrographs the character of

*Physicist and Assistant Physicist, respectively, Bureau of Standards.

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¹Henry S. Rawdon and Marjorie G. Lorentz, "Metallographic Etching Reagents. I—For Copper," Bureau of Standards Sci. Paper 399; also forthcoming Sci. Paper, second of the series, "Metallographic Reagents. II—For Copper Alloys, Nickel and the Alpha Alloys of Nickel."

RESULTS OBTAINED WITH CONCENTRATED HYDROCHLORIC ACID AS ETCHING REAGENT

Material Etched	Etching Period	Results
Elec. nickel	1 hour	No action
Cast nickel	1 hour	Excellent contrast
Drawn nickel	1 hour	Excellent contrast
Rolled nickel	1 hour	Excellent contrast
Cast Monel	1 hour	Excellent contrast
Hot-rolled Monel	1 hour	Excellent contrast
Cold-drawn Monel	1 hour	Excellent contrast
Nickel sheet	1 hour	Excellent contrast
Elec. nickel melted and cooled in vacuo	2 hours	Poor; no contrast
Cast cupronickel (45 per cent Ni)	1 hour	Excellent contrast
Cast cupronickel (28 per cent Ni)	15 min.	Fair; no contrast
Rolled cupronickel (20 per cent Ni)	20 min.	Fair contrast
Manganese nickel (3 per cent Ni)	1 hour	Excellent contrast
Annealed nickel-brass (26 per cent Ni)	30 min.	Fair contrast
Annealed nickel-brass (17 per cent Ni)	30 min.	Fair contrast
Cold-rolled nickel-brass (17 per cent Ni)	15 min.	Poor contrast
Nickel-brass (5 per cent Ni)	15 min.	Poor contrast

the results which may be obtained by its use is illustrated; for comparison, there is shown also the structure as revealed by one of the common reagents. One of the best of these has been described by Merica² and consists of 50 per cent concentrated nitric acid, glacial acetic acid, 25 per cent, and water, 25 per cent; the proportions may be varied somewhat, however. The marked contrast and absence of pitting in the structures as revealed by etching with hydrochloric acid are very evident. One feature which appears to be the principal disadvantage in this use of hydrochloric acid is the long etching period required. As shown in the accompanying table, it was often necessary to keep the specimen immersed in the acid for 1 hour or more.

The results summarized in the table show that the general effect of concentrated hydrochloric acid is a contrast etch pattern. The best results by far were obtained with nickel and with alloy of high-nickel content. With alloys in which copper forms a considerable percentage of the composition, the results obtained were decidedly inferior to those with the high-nickel specimens. Micrographs showing the appearance of the microstructure as revealed by concentrated hydro-

²P. D. Merica, "Nickel," Bureau of Standards Circular 100.

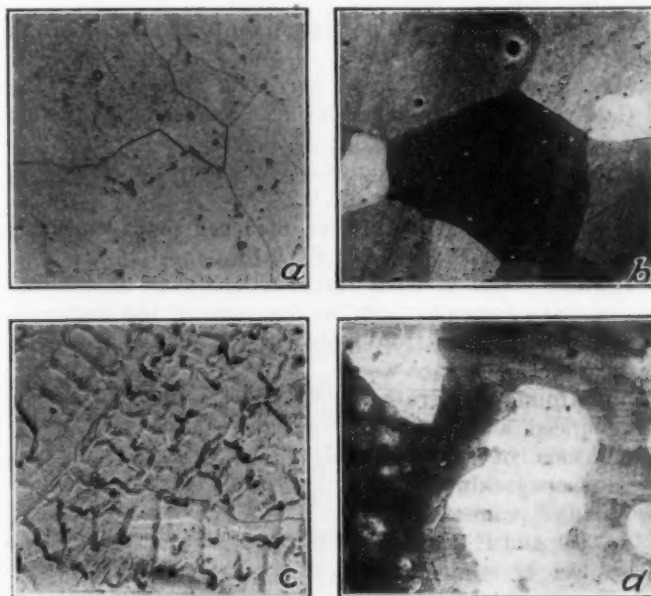


FIG. 1. MICROSTRUCTURE OF CAST NICKEL AND CAST MONEL METAL. $\times 85$

- Cast nickel etched with acetic acid solution of nitric acid, 45 seconds.
- Same material as a, etched with concentrated hydrochloric acid 1 hour.
- Cast Monel metal, etched as in a, 15 seconds.
- Same material as c, etched as in b.

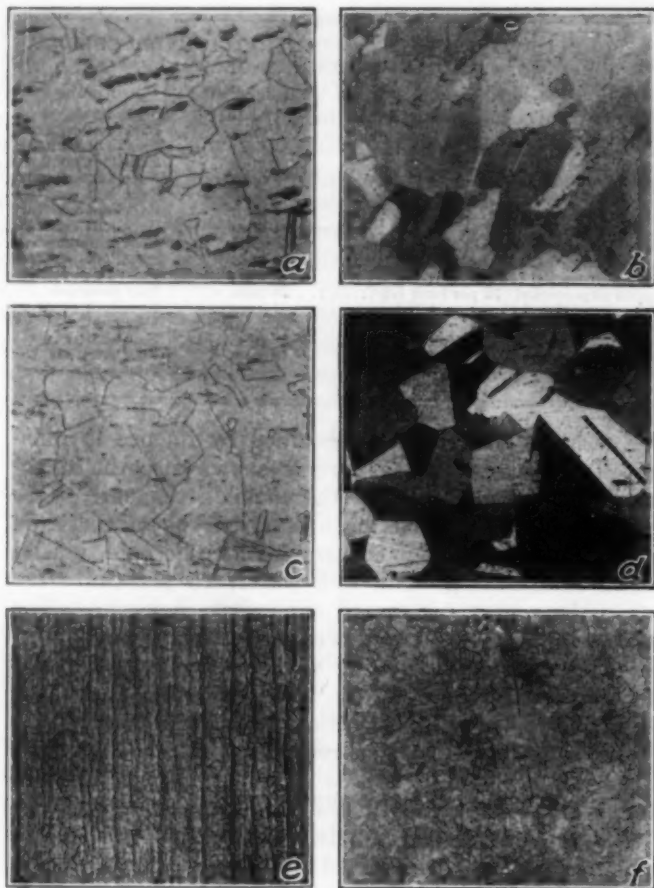


FIG. 2. MICROSTRUCTURE OF WROUGHT NICKEL AND MONEL METAL. $\times 85$
 a. Sheet nickel, etched with acetic acid solution of nitric acid for 2 minutes.
 b. Same material as a, etched with concentrated hydrochloric acid for 1 hour.
 c. "Manganese-nickel," etched as in a, 30 seconds.
 d. Same material as c, etched as in b.
 e. Hot-rolled Monel metal, etched as in a for 15 seconds.
 f. Same material as in e, etched as in b.

chloric acid and by the acetic acid solution of nitric acid are given for the following materials:

Cast nickel (Ni, 99.3 per cent; Cu, 0.13; Fe, 0.25; C, 0.10; Si, 0.05).

Manganese-nickel (Ni, 97 per cent; Mn, 3).

Cold-rolled nickel sheet (Ni, 99.1 per cent; Cu, 0.35; Fe, 0.40; Mn, 0.05; C, 0.03; Si, 0.08).

Cast Monel metal (Ni, 66.3 per cent; Cu, 28.5; Fe, 2.49; Mn, 1.85; C, 0.12; Si, 0.73).

Hot-rolled Monel metal (Ni, 66.6 per cent; Cu, 29.3; Fe, 1.90; Mn, 1.76; C, 0.13; Si, 0.18).

Results obtained with ferric chloride as an etching reagent are somewhat similar for some of the materials to those described for hydrochloric acid. However, pitting of the surface was usually found to be rather pronounced and the nice gradations of light and shade were lacking. With oxidizing reagents such as H_2SO_4 and H_2O_2 , the appearance of the etched specimen was in all cases inferior to that produced by the nitric acid solution illustrated in the micrographs, and the pitting of the material was, in most cases, very pronounced.

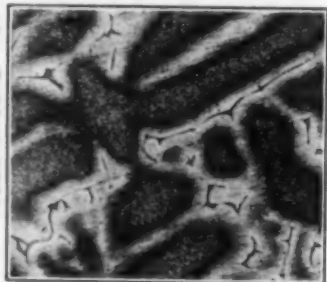


FIG. 3. MICROSTRUCTURE OF CAST ALUMINUM-BRONZE. (8 PER CENT AL). $\times 85$
 Etching reagent, concentrated hydrochloric acid, 15 minutes.

The action of the reagent upon the common copper alloys was also examined. With bronze and aluminum-bronze results were obtained which were equal to those given by the usual reagents. Fig. 3 shows the results obtained with a cast aluminum-bronze (8 per cent Al), an alloy which is etched satisfactorily with considerable difficulty. For most of the common copper alloys, however, superior results can be obtained much more easily with the reagents usually employed.

New Chemistry Building at Iowa City

Prof. Edward Bartow, head of the department of chemistry at the State University of Iowa, in a recent address outlined the plans for the new chemistry building which is being erected at Iowa City. An initial appropriation of \$400,000 has been made for commencing the construction of the 6-story building which, when completed, is to occupy an entire city block. It is to include a central structure facing the east with three wings extending to the north and south. The main lecture room or auditorium will be located in the central structure on the east side of the building. On the lower level there will be two entrances to the room, which will enable it to be filled or cleared without delay—a desirable feature in changing classes. Back of the main lecture room there will be a preparation room which will also serve the smaller lecture rooms.

The library, furnishing shelf room for 40,000 books and table room for 200 students, is to be placed above the main lecture room and will be easily accessible both from the street and from all parts of the building.

The storerooms will be located in the geographical center of the block, one on each floor. The storeroom on the lower floor will be devoted to reception of supplies, that on the second floor to general storage, on the third, fourth, fifth and sixth floors to delivery rooms for the laboratories. On the sixth floor connection will be made through a corridor to the laboratories located on the east front.

With rooms for general utility, such as the storerooms, lecture rooms and library, in this central portion of the building, access to them from laboratories in the wings will be easy. This plan for the building was chosen rather than that of a hollow square because it makes it possible to reach any part of the building through corridors rather than through laboratories; the distances between the laboratories and general utility rooms are reduced to a minimum, and part of the building can be constructed now and wings to complete the building can be added later without interfering with the part already constructed.

Ground was broken on the southeast corner of the city block on August 9, 1921. Approximately one-half of the central structure and two of the wings are to be built immediately. In accordance with the general plan, wings may be added to the part under construction in any one or all of three places.

Each wing will contain four floors, 57 ft. wide and 81 ft. long, with light on three sides. This space can be used as a whole or divided into smaller rooms. Small laboratories, offices and special rooms can be cut off from either end of these wings and others will be placed along the corridors and on the second, third and fourth floors of the storeroom unit. Special rooms of this type are needed for instructors and for advanced students. Seminar room in which special reference books can be placed have been provided in the central portion.

Importance of the Olefine Gases and Their Derivatives II—Diethyl Sulphate*

Diethyl Sulphate of High Purity Can Be Prepared From Pure Ethylene and Sulphuric Acid—
Advantages as an Ethylating Agent: Low Volatility, Which Obviates Use of Autoclaves;
High Reaction Intensity; It Is Non-Toxic, Non-Flammable and Non-Corrosive

By G. O. CURME, JR., AND H. R. CURME

IN A consideration of the many possible derivatives of ethylene, aside from those best known as a result of numerous recent publications, diethyl sulphate ("ethyl sulphate") is deserving of especial attention. It recommends itself particularly on account of the improvement it offers in many old and long-established processes, and also on account of the new fields of chemical operation which it promises to develop. As is generally known, the homologous dimethyl sulphate has already been widely used for purposes of introducing the methyl group, and apparently for no reason other than its more general commercial availability has progressed relatively much further in its field than has the diethyl sulphate in the field of ethylation. That this has been done commercially in spite of an average price high in proportion to the value of the methyl groups contained is indeed a tribute to the smoothness of reaction which characterizes the alkylation by means of the alkyl sulphates. Now that the diethyl sulphate is available in even more abundant quantities, it may confidently be expected that its use will also expand.

The preparation and isolation of diethyl sulphate, $(C_2H_5)_2SO_4$, itself is not a new accomplishment, as this material was described by Wetherill¹ in 1848 as a product of the interaction of sulphur trioxide on absolute ether. It is, when pure, a colorless liquid, with a pleasant though faint ethereal odor. It boils without decomposition at 96 deg. C. at 15 mm. pressure, and at 120.5 deg. C. at 45 mm. At temperatures above 140 deg. C. it begins to decompose slowly, and at 208 deg. C. it boils with considerable decomposition—the true boiling point probably lies several degrees higher. It has the density $D_{4}^{20} = 1.1837$.² On cooling it forms crystals which melt at -24.5 deg. C. This liquid is entirely neutral in reaction. It is not miscible with cold water; with warm water it is slowly hydrolyzed, and on boiling it yields eventually two molecules of ethyl alcohol and one of sulphuric acid. Diethyl sulphate is not flammable.

Since its discovery numerous investigators have studied it and have worked with it in a variety of ways. From the first it has been recognized as an ethylation agent of marked value, although in all hands it has not met with the same success. For instance, Lassar-Cohn³ states that in his experience it has not given satisfactory results, and yet Weyl⁴ a few years later

says, "Diethyl sulphate has attained great significance for ethylation." This difference in results may well be due to any of several causes, as the earlier experimenters may have had impure samples at their disposal. Their experience with the dimethyl sulphate may have led them to follow methods worked out for its use too closely, or indeed with a limited supply available the tests may have been carried out improperly. In any event positive evidence has since shown the value of this reagent and to the writers' knowledge in certain industrial processes it is being used today with commercial yields approaching the theoretical.

COMMERCIAL PRODUCTION

Only within the last twenty years have there been attempts to utilize diethyl sulphate commercially, and these attempts have been put under the difficulty of having a rather expensive source of material. In 1902 E. Merck⁵ obtained a patent on the production of diethyl sulphate by the vacuum distillation of the product obtained by mixing ethyl alcohol and sulphur trioxide. Later patents⁶ have proposed the production by means of the dry distillation in vacuo of sodium ethyl sulphate, and further by the interaction of chlorosulphonic acid and absolute ether.⁷ In all of these processes the initial product is highly impure and requires extensive after-treatment to obtain a commercially satisfactory product. Also the yields are rather poor, being in general less than 50 per cent of that demanded by theory. In the work carried on under the writers' direction, it was observed that the expense of using anhydrous materials, or vacuum distillations, could be avoided by using, instead of alcohol, the product of its dehydration—namely, ethylene. It was found that with pure ethylene and commercial sulphuric acid (66 deg. Bé.) a continuous cycle could be established producing high purity diethyl sulphate directly.⁸ The material from this source is now commercially available, and is finding a variety of technical applications.

ONLY ORDINARY PRECAUTIONS REQUIRED IN HANDLING

In the case of the homologous dimethyl sulphate a toxic effect from handling the material and inhaling its vapors has been noted and described by Weber.⁹ In this same report it is stated that the acute inflammation characteristic of dimethyl sulphate is not noted at all with the diethyl sulphate, and only the general action on the central nervous system is observed. From

*A contribution from the Mellon Institute of Industrial Research, of the University of Pittsburgh.

¹This article, the second of a series of five, treats of the general properties of a little known commercial reagent which is now made available through the development work carried out by the Carbide & Carbon Chemicals Corporation, at Clendenin, W. Va. Part I was published Nov. 16, 1921, p. 907.

²Wetherill, *Ann.*, vol. 66, p. 117 (1848).

³Claesson, *J. prakt. Chem.*, (2) vol. 19, p. 257 (1879).

⁴Lassar-Cohn, 4th ed. (1907) *Spez. Teil*, p. 301.

⁵Th. Weyl, "Die Methoden der Organischen Chemie" (1911), vol. 2, p. 1268.

⁶Merck, Ger. Pat. 133,542 (1902).

⁷Lillienfeld, U. S. Patent 1,074,633 (1913).

⁸Wolf, U. S. Patent 1,101,373 (1914).

⁹H. R. Curme, U. S. Patent 1,339,947 (1920).

¹⁰Weber, *Archiv. exp. Path. Pharm.*, vol. 47, p. 113 (1901).

a hygienic standpoint, diethyl sulphate is no more dangerous to handle than organic liquids such as aniline, benzene, etc. It has been the writers' experience, as well as that of others who have used this material on a large scale, that, observing only the most usual precautions against inhalation of the fumes of the heated material, it is possible for workmen to handle diethyl sulphate continuously without any evil effects whatsoever. It has been stated erroneously in previous publications that the toxic effect of the dimethyl sulphate is also characteristic of the diethyl sulphate. Accordingly, in order not to limit the usefulness of this reagent, it is well to correct this error which has gained admission to the literature. It is also worthy of attention that the toxicity of the dimethyl sulphate itself has been overemphasized, as has recently been pointed out by Mueller.¹⁰ Undoubtedly, a closer knowledge of such substances will provide a safe working procedure that also permits the full utilization of their valuable properties.

ADVANTAGES AS ETHYLATING AGENT

By means of this commercially new reagent it is possible to accomplish, almost without exception, the ethylation of any material which has heretofore been ethylated by any means whatsoever. Moreover, this ethylation may be brought about in plant operation with greater ease and simplicity than heretofore possible. Owing to its low volatility (b.p. 208 deg. C.), it is not necessary to use autoclaves for carrying on such reactions; any closed vessel fitted with a simple reflux and operating at atmospheric pressure will suffice. Also, as this reagent is quite neutral and is commonly used under neutral or alkaline conditions, a wider choice of materials for construction of equipment is possible than in many ethylations where strong acids are present. The material is non-flammable and therefore avoids any fire risk in its use.

In comparison with ethylation by means of ethyl bromide, the use of diethyl sulphate recommends itself both on grounds of simplified procedure, as well as economy of operation. In addition to avoiding the use of an autoclave, as above mentioned, the losses, in handling and storing of a volatile material, are eliminated, and the troublesome necessity for working over the bromine residues is entirely avoided. All of the value of the ethyl sulphate lies in the ethyl groups and the sulphate radical in most cases is not worth recovery.

A further important advantage, particularly in the case of diethyl sulphate derived from ethylene, is that only the purest ethyl derivatives are formed, containing no trace of homologous methyl or propyl compounds. Commercially this is equivalent to the use of tax-paid alcohol derivatives, although, of course, no alcohol is used in the production of the products.

GENERAL CONDITIONS FOR USE

The conditions under which reaction proceeds most smoothly are, of course, different in each separate case. However, in general, it is desirable to operate in the absence of water, if possible, as was suggested by Ullmann¹¹ for such alkylations as early as 1902. With diethyl sulphate it is generally desirable to use a slightly higher temperature than with dimethyl sulphate in order to get a similar velocity of reaction; but otherwise conditions are similar. Some reactions,

such as in the ethylation of aniline, need no heating whatsoever, but warm up from room temperature so as to need cooling. In most cases at temperatures between 100 and 125 deg. C. the reaction is quite rapid, and at temperatures above that it is possible that the reaction will become too violent. In all cases by controlling the temperature, or both temperature and rate of addition of the reagent, it is possible to maintain any desired rate of reaction. Frequently it is desirable to mix the finely powdered—if solid—material to be ethylated with the diethyl sulphate and then to heat the charge gently until reaction is complete. In other cases an inert anhydrous solvent, such as benzene or solvent naphtha, gives excellent results. As the reagent is miscible in all proportions with most organic liquids, the reaction can be brought about by simple admixture, in the case of ethylating a liquid. Usually the previous formation of the sodium salt of a material to be ethylated is desirable when such can easily be done, and in other cases the presence of an equivalent amount of caustic soda is desirable to prevent the formation of free acid.

Under the general conditions just described it is usually possible to get a great intensity of ethylation with the first of the two ethyl groups and a practically theoretical yield, both reckoned on this ethyl group and on the other material. The second ethyl group reacts exactly as the ethyl group of sodium ethyl sulphate and consequently with less intensity. With some reactions, such as the production of volatile ethyl esters, it is possible to get a high yield with this second ethyl group also, although in other cases it is best to stop the reaction when the first ethyl group has reacted, and to make use of the residual sodium ethyl sulphate, or ethyl hydrogen sulphate, for some other purpose.

COMMERCIAL ETHYL COMPOUNDS PREPARED

It is beyond the scope of this résumé to give complete directions for making all ethyl compounds, or even a list thereof, for it is realized that this work is still largely incomplete. It will be of interest, however, to mention some of the commercial products which have to date been successfully produced by means of ethylation with diethyl sulphate. Ethyl chloride, ethyl bromide and ethyl iodide have been prepared with great ease and in almost quantitative yields. The esters of the weaker inorganic acids, such as ethyl nitrite, ethyl sulphite, ethyl mercaptan and ethyl sulphide, are readily produced in highest purity and good yields. The esters of all organic acids attempted have been produced easily, and in such cases as ethyl cinnamate, where the value of the acid radical is relatively great, a highly pure derivative has been obtained with negligible loss of material. The ethyl esters of the higher fatty acids, such as ethyl laurate, ethyl oleate, ethyl stearate, etc., have been prepared easily, and through this means the pure fatty acids themselves have been readily isolated by redistillation of the esters. Ethylated phenols may be obtained quantitatively. Ethylated amino compounds are very easily prepared indeed, although care must be taken to get proper conditions to prevent the formation of complex mixtures of mono-, di- and tri-ethyl derivatives, as is common with all ethylations of amines. Finally, starch and even cellulose have been ethylated to give ethers,¹² in general similar to the esters of the

¹⁰Chem. & Met. Eng., vol. 23, p. 833 (1920).

¹¹Ullman, Ber., vol. 35, p. 322 (1902).

¹²Lillenfeld, Brit. Pats. 12,854 (1912) and 149,320 (1920); U. S. Pats. 1,217,027 (1917); 1,217,028 (1917). Clarke, U. S. Pat. 1,357,614 (1920). Worden, "Technology of Cellulose Esters," Van Nostrand, (1916), vol. 8, p. 2505.

same materials, but naturally more stable and less subject to hydrolysis and corrosion of metal in contact with the material thus produced.

The possible applications of this reagent in our future developments of chemistry are difficult to predict at this time; but, in view of the undeveloped possibilities which suggest themselves in the fields of dyestuffs, pharmaceuticals, solvents, plastics, varnishes and films, it would be safe to expect that the technical application of ethylene in the production of commercial diethyl sulphate will be of importance in the chemistry of the future.

SUMMARY

In brief, the advantages which this commercially new ethylating agent offers are:

1. It permits rapid and complete ethylation without pressure vessels or autoclaves.
2. It has a high intensity of reaction, thus economizing valuable material.
3. It avoids the necessity of recovering any expensive acid radical.
4. It may be handled and stored without loss due to its low volatility.
5. It is non-toxic, non-flammable and non-corrosive.

A Symposium on Industrial Management

VARIOUS phases of industrial management were discussed by well-known experts at the annual convention of the Industrial Relations Association of America, held in New York on Nov. 1-4. Secretary of Commerce Hoover, Secretary of Labor Davis, B. Seebom Rowntree, president of the large British cocoa works of Rowntree & Co., Ltd., and many officials and employment managers for prominent American industries spoke on labor conditions, personnel work and such closely related subjects as departmental costs, living conditions, wages, seasonal production, and unemployment.

Space limitations prevent an extended account of the open meetings and sectional conferences, but a few papers of more intimate interest to our readers have been abstracted in the paragraphs which follow:

Human Relations in Industry.—A discussion of the fundamental principles of human relations in industry by L. A. Osborne, president of the Westinghouse International Electric Co., was well received by the convention. Mr. Osborne divided industrial relations into two categories, economical and ethical, and analyzed these according to his own viewpoint. He made a plea for cordial relations between employer and employee, saying that on no other basis could industry thrive. On the subject of wages he stated as his opinion that wages should be based on production.

Taking the Mystery Out of Business.—S. R. Rectanus, personnel director of the American Rolling Mills Co., explained how his company is winning the confidence of its employees by "taking the mystery out of business." Advisory committees are elected by secret ballot, the privilege of voting and holding office being confined to employees who have been with the company a year. These committees take up problems of production, working conditions and other matters which affect both the company and the workers. The objects of the company, the way in which it conducts its business, the conditions of the market in general and the eco-

nomics of business are discussed and made clear so that every man and woman in the plant has, or can have, a clear understanding as to the methods and practices of the company.

It is this company's belief that practically all of the mystery which has surrounded business so far as its employees are concerned is not only unnecessary but is a direct cause of much distrust and misunderstanding.

Use of Graphic Charts.—Along this same line, E. K. Hall, vice-president, American Telephone & Telegraph Co., stated that one of the principal causes of industrial unrest is the fact that working men and women feel that they have no standing in the industry, but are simply small cogs in a huge machine. One of the ways in which this misconception is being overcome is by the preparation of organization charts which include everyone in the central station or district, from the manager down to the janitor, making them all feel that they are part of the family. This is in distinct contrast to the usual organization chart which shows only the heads of various departments and leaves all the rest in an unclassified mass. The result of this change has been increased confidence and an excellent spirit of co-operation among the employees of the company.

Hoover's Analysis of Labor Unrest.—The third session of the convention was held in conjunction with a dinner meeting of the Academy of Political Science. Herbert Hoover, presiding officer, in pointing out the value of good will and co-operation in industry, gave a brief analysis of labor conditions as they exist today.

Mr. Hoover referred to the universal desire for the limitation of armament, not only internationally but industrially, stating that warfare is becoming more destructive year by year. He also referred to altercations between employer and employee, declaring that it was wholly idle to deny the existence of conflicting interests between these parties. "But," he added, "there are wide areas of activity in which their interests coincide. It is the part of statesmanship to recognize identity of interest where it exists in order to reduce the area of conflict."

Unemployment was given as largely responsible for industrial unrest. "One of the causes of ill will that weighs heavily upon the community," said the speaker, "is the whole problem of unemployment. I know of nothing that more filled the mind of the recent conference, while dealing mainly with emergency matters, than the necessity to develop further remedy, first, for the vast calamities of unemployment in the cyclic periods of depression, and, second, some assurance to the individual of reasonable economic security—to remove the fear of total family disaster in the loss of the job."

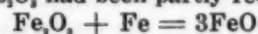
Viewpoint of the British Employer.—B. Seebom Rowntree, president of Rowntree & Co., cocoa works, York, England, spoke on "Conditions Essential to Industrial Co-operation from a British Employer's Point of View." He complimented American business men upon the efficiency with which they have handled their material problems, but stated that the same effort is not being exerted on the human problems. Industrial unrest, according to Mr. Rowntree, is a reflection on the ability and intelligence of the employer. To secure industrial peace, he must pay the price, consisting of commensurate wages, sufficiently short hours, a guaranteed economic security to the worker, and possibly a proper share of the profits of the work.

Solid Solutions of Oxygen in Iron

TWO papers were read on this subject before the British Iron and Steel Institute's spring meeting, 1921, one by Dr. J. E. Stead and the other by J. H. Whiteley. In the former Dr. Stead notes that in general solid solutions in iron are electro-positive to pure iron, and therefore when in contact with the latter remain white on brief attack by a cupric reagent. However, many attempts to verify Le Chatelier and Bogitch's statement that iron and its oxide or oxygen formed such a solid solution were fruitless, even when electrolytic iron was burned on a magnesia-lined base in such a way that the fused iron was shot full of minute black globules and covered with thick layers of cinder. However, if strips of electrolytic iron or commercial soft steel were heated to 1,000 deg. C. in air, a thin sheath of finely crystalline iron (which resisted cupric attack) is found to separate the base and the adherent scale. White "resist" lines also appear at welded junctions.

More recently, Dr. Stead examined a steel casing very low in phosphorus from a hot blast stove, heated many years in an oxidizing atmosphere. It was extremely brittle; shock fracture commenced as intercrystalline at the surface, but deeper in was transgranular. Veins of oxide of iron completely separated the surface

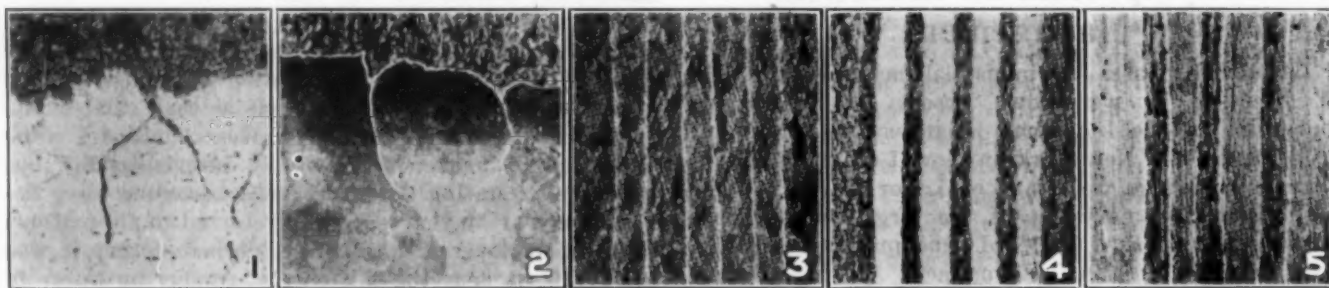
He then investigated the effect of oxygen, phosphorus remaining constant. Very pure electrolytic iron was oxidized to scale in an electric muffle. This oxide was used to pack other pieces of iron into a small steel cylinder, the latter tightly plugged, cased in a strong silica tube and the whole heated 2 hours in a gas furnace to approximately 1,350 deg. C. On opening, the oxide had fused to a solid mass, and chemical analysis indicated that Fe_2O_3 had been partly reduced, as follows:



Unetched sections showed the metal to contain a number of new globular particles, thought to be of the same composition as the packing material. It is unknown whether this material worked itself in at high temperature, or separated from solid solution on cooling.

A pile consisting of several alternate layers of this oxidized and the original iron was prepared, placed in a tightly plugged steel cylinder containing nitrogen, heated and hammered down until the whole had welded together. Fig. 3 shows a cross-section of the weld after etching, which is not comparable with the least variation in phosphorus (Fig. 4).

Armco iron was then deoxidized by heating in H_2 for 2½ hours at about 1,350 deg. C., a pile of deoxidized and original strips made, and welded in a tube containing H_2 . Temperature was held below 900 deg. C., and



FIGS. 1 TO 5.

Figs. 1 and 2. Oxidized steel plate, showing scale at top, steel below, intergranular oxides and globular inclusions. $\times 50$. Fig. 1 etched with dilute acid. Fig. 2 etched with cupric reagent.

Fig. 3. Welded alternate strips of oxidized and pure electrolytic iron. $\times 70$. Etched with Stead's reagent.

Fig. 4. Weld of phosphorized electrolytic iron plates. Analysis of strips: 0.005, 0.13, 0.005, 0.07, 0.005, 0.045, 0.005, 0.023, 0.005. $\times 60$. Etched with Rosenhain's reagent.

Fig. 5. Welded alternate strips of Armco iron. Etched with Stead's reagent. $\times 70$.

crystals, as shown in Fig. 1 (unetched), while white "resist" lines appeared after cupric etching (Fig. 2) at the surface, and on down, outlining the crystals, even below the point where oxide accumulations were formerly observable. This latter fact suggests that oxygen penetrates sound steel at the crystal boundaries, forming solid solutions, which, when supersaturated, produce insoluble oxide. Annealing in H_2 at 1,200 deg. C. removed the foreign material entirely at the grain borders, and with them the ability to form "resist" lines on cupric attack, either there or further down.

In view of the low P content (0.007 per cent), it was thought that phosphorus might have migrated to the scale, but chemical analysis failed to reveal any there. Instead S 0.80 per cent was found, evidently absorbed from the furnace gases. The globules within the iron crystals had the characteristic dove color of manganese sulphide—quite different from those at the grain boundaries—and indicates that this S may have been absorbed from the exterior.

Whiteley, in the second paper mentioned ("Cupric Etching Effects Produced by Phosphorus and Oxygen in Iron"), first shows that the cupric reagent clearly distinguishes phosphorus differences of no more than 0.018 per cent in oxygen-free electrolytic iron (Fig. 4).

welding was quickly done to prevent reduction of oxide in the original metal, and to avoid melting the $\text{FeO}:\text{FeS}$ eutectic present. After etching with picric acid, the reduced strips plainly have lost their oxide spots. The same, etched with Stead's reagent, is shown in Fig. 5. Here the deoxidized material is more resistant than the original, which gathered most of the copper. White resist lines appear at the junctions, but always in the original material. Crystallization can clearly be seen at high magnifications to take place across these resist lines, from piece to piece—a complete weld has formed, even though a heterogeneous solid solution remains. No such white resist lines occur after welding unoxidized electrolytic strips.

Apart from this effect, oxygen in uneven distribution has not been found by Whiteley to yield effects similar to those given by even the smallest variation of phosphorus.

Rubber Used During the First 6 Months of 1921

Data compiled by the Rubber Association of America show that during the first 6 months of this year 131,979,361 lb. of crude rubber was used in the manufacture of rubber products, and that 33,527,306 lb. was reclaimed from 45,669,424 lb. scrap rubber.

Structure and Properties of Alternately Electrodeposited Metals*

If Relatively Thin Layers of Nickel Are Interposed During the Deposition of Copper, the Growth of the Copper Crystals Is Restrained, and the Tensile Strength of the Deposit Is Increased—Applications of the Process

By WILLIAM BLUM
Chemist, Bureau of Standards

A FEW years ago attempts were made by the U. S. Bureau of Engraving and Printing to reproduce its printing plates by electrodeposition. It was then found that plates 0.25-in. thick, consisting entirely of electrodeposited copper (with nickel printing face) did not possess sufficient strength—i.e., they bent when in service upon the presses. George U. Rose, Jr., chief of the Engraving Division, who was conducting these experiments, conceived the idea of "re-enforcing" the copper plates by the deposition of layers of nickel at intervals through the copper. He then found that plates so produced possessed the necessary strength to meet the requirements. This process of depositing alternate layers of nickel and copper, which has been patented by Mr. Rose, is employed in the new electrolytic plant of the Bureau of Engraving and Printing.¹

PRINCIPLES INVOLVED

The purpose of this paper is to show that in so apparently trivial an innovation as the alternate deposition of two metals a new principle possibly of wide application is involved. Consideration by the author of the effect of the layers of nickel led to the thought that this is probably due not so much to the higher tensile strength of the nickel as to the influence of the nickel layers upon the structure and properties of the intervening copper. A few simple experiments and photographs showed that such is the case.

It has long been recognized that in the deposition of a metal the initial deposit is usually fine grained but that the crystals become larger as the deposit increases in thickness. This was well illustrated in the photographs showing the structure of electrotyping copper.² If, as may generally be assumed, fine-grained deposits have the greatest hardness and tensile strength, conditions leading to the formation of fine crystals are usually desirable, especially high current density, low temperature and agitation. For the thickness used in regular electrotyping—i.e., up to 0.25 mm. (0.010 in.)—there is no difficulty in obtaining relatively hard copper deposits by the application of these principles. When, however, as in the case in question, a thickness of 6 mm. (0.25 in.) or more is required, the use of a high current density leads to the excessive formation of "trees." Moreover, with large plates the degree of agitation is practically confined to that obtainable by compressed air, and usually it is not feasible to apply artificial cooling to the solution. In consequence most of the thick cop-

per plates produced electrolytically in various plants have been deposited at low current densities and have had relatively low hardness and tensile strength.

EXPERIMENTS

If the effect of each layer of nickel is due to its influence in preventing further growth of the copper crystals, the actual change in mechanical properties—e.g., tensile strength—should be determined not so much by the relative thickness of the nickel and copper layers as by the frequency with which the nickel layers are interdeposited. In order to determine whether such is the case, a number of plates were prepared in which both the frequency and the thickness of the nickel layers were varied. For purposes of comparison a number of plates of pure copper were deposited. The plates were machined and ground to a smooth surface, after which specimens were cut and tested for tensile strength and elongation.³ The test results are shown in Table I.

On all these specimens an initial coat of nickel (about 0.025 mm. or 0.001 in.) was deposited. All the nickel layers were produced without agitation at a current density of 2 amp. per sq.dm. (19 amp. per sq.ft.) in "Watts' solution" containing

	G. per Liter	Oz. per Gal.
NiSO ₄ ·7H ₂ O.....	240	32
NiCl ₂ ·6H ₂ O.....	15	2
H ₃ BO ₃	30	4

(from which as determined in subsequent experiments, relatively soft nickel is obtained). The copper deposits were made in an agitated solution containing:

	G. per Liter	Oz. per Gal.
CuSO ₄ ·5H ₂ O.....	200	27
H ₂ SO ₄	100	13

From the data in Table I it is evident that of those deposits which contained copper and nickel in the ratio of 10 to 1 (by thickness) by far the greatest strength was produced when the nickel layers were introduced most frequently. On the other hand the presence of twice the above proportion of nickel produced only a slightly increased strength. It is interesting to note the beneficial effect of increasing current density upon the strength and structure of the pure copper deposits, as has been pointed out by Bancroft⁴ and recently illustrated by the author.⁵ Thus in Fig. 1, it may be observed that as the current density is increased the long crystals in A are broken up appreciably at the higher current density used in B; which finally leads to the

*Paper presented at the Lake Placid meeting of the American Electrochemical Society, Oct. 1, 1921. Published by permission of the Director of the Bureau of Standards.

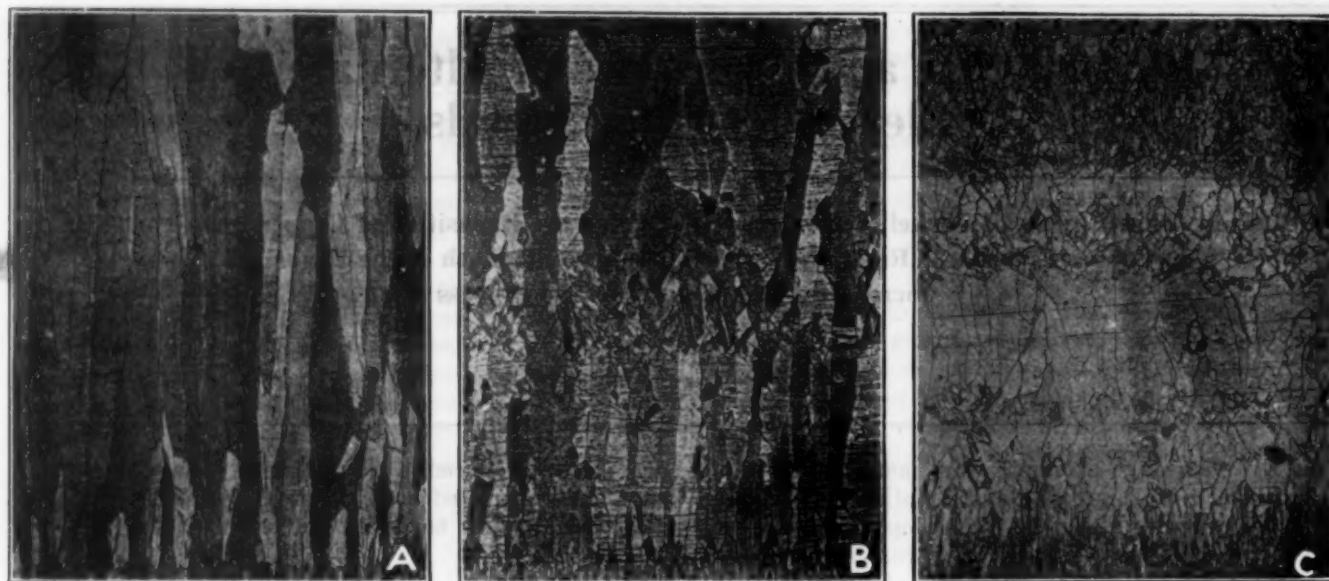
²See also CHEM. & MET. ENG., vol. 25, p. 320, Aug. 24, 1921.

³W. Blum, H. D. Holler, and H. S. Rawdon. *Trans. Am. Electrochem. Soc.*, 1916, vol. 30, p. 159.

⁴The author is indebted to Dr. L. B. Tuckerman of this bureau, who kindly conducted these mechanical tests.

⁵*Trans. Am. Electrochem. Soc.*, 1904, vol. 6, p. 27.

⁶*Trans. Am. Electrochem. Soc.*, 1919, vol. 36, p. 57.

FIG. 1. STRUCTURE OF HEAVY COPPER DEPOSITS ($\times 100$)

Current Density		Ultimate Tensile Strength	
A	30 amp. per sq.ft.	12,300 lb. per sq.in.	
B	60 amp. per sq.ft.	24,000 lb. per sq.in.	
C	90 amp. per sq.ft.	26,600 lb. per sq.in.	

TABLE I. MECHANICAL PROPERTIES OF ELECTROLYTIC COPPER AND COPPER-NICKEL PLATES

Plate No.	Current Density		Copper Thickness of Each Layer		Nickel Thickness of Each Layer		Thickness Ratio Cu:Ni	Ultimate Tensile Strength		Per Cent Above No. 2	Elongation per Cent (in 5 Cm. or 2 In.)
	Amp. per Sq. Dm.	Amp. per Sq. Ft.	Mm.	In.	Mm.	In.		Kg. per Sq. Cm.	Lb. per Sq. In.		
1	3	28	....	....	....	....	....	870	12,300	..	1
2	6	56	....	....	....	....	....	1,690	23,990	..	10
3	9	84	....	....	....	....	....	1,870	26,600	11	10
4	6	56	0.25	0.001	0.025	0.001	10:1	2,240	31,900	33	8
5	6	56	0.125	0.015	0.0125	0.0005	10:1	2,480	35,300	47	9
6	6	56	0.063	0.0025	0.0063	0.00025	10:1	2,890	41,100	71	13
7	6	56	0.125	0.005	0.025	0.001	5:1	3,010	42,900	79	7

formation of twinned crystals at still higher current densities. However, even at 6 amp. per sq.dm. (56 amp. per sq.ft.) marked treeing occurred, which was still more pronounced at higher current densities.

That the changes in strength produced by the nickel layers were caused principally by a decrease in the average size of the copper crystals is illustrated by the photographs of Fig. 2. In each case it may be observed that the copper crystals increase in size as de-

position continues, but that when a layer of nickel is interposed, further growth ceases and new fine crystals are deposited. Also it is obvious that in Fig. 2, B, in which the nickel layers are most frequent, the average size of the copper crystals is smaller than in A or C. It is true, however, that the copper crystals become slightly coarser in each layer as the deposition continues, which explains why the nickel layers do not entirely eliminate the roughness of the deposits. No

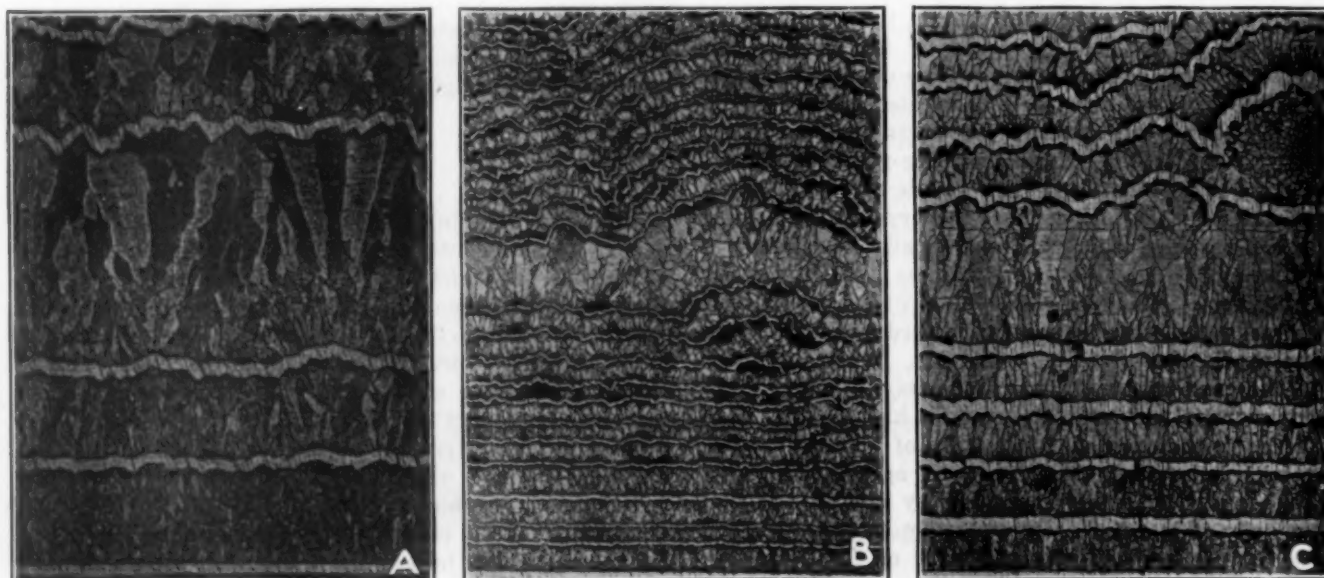


FIG. 2. STRUCTURE OF ALTERNATE DEPOSITS OF COPPER AND NICKEL ($\times 100$)

Thickness Ratio Cu: Ni	Layers of Each per Inch	Ultimate Tensile Strength
A — 10:1	90	32,000 lb. per sq.in.
B — 10:1	560	41,000 lb. per sq.in.
C — 5:1	170	42,000 lb. per sq.in.

attempt was made in these experiments to determine the extreme effects which might be produced by very frequent alternation as, for example, in a mechanically operated continuous process.

In addition to increasing the strength of the deposits, the presence of the nickel layers reduces materially the tendency to treeing. This is to be expected, as in effect a "tree" is simply a large crystal or series of crystals caused by favorable conditions. Among these is the high potential drop through the solution, which, under otherwise similar conditions, must accompany a high current density. Any procedure which will decrease the formation of trees is very helpful in permitting the use of higher current densities in the production of thick deposits.

That the above effects of alternation are not confined to these two metals is shown by Fig. 3, in which layers of silver (from the usual cyanide solution) are alternated with layers of copper from the sulphate solution. The choice of the two metals is limited only by the condition that, in the solutions employed, neither must cause deposition of the other by immersion to such an extent as to prevent proper adhesion of successive layers. (Where there is only a slight tendency for such deposition, it can be prevented by having the cathode connected in the circuit before introducing it into the solution.)

If the process depends upon the different structure of the interdeposited metal, the same result should be accomplished if both layers are composed of the same metal, provided they have different crystalline structures. It is well known that copper deposited from a cyanide solution is much finer grained than that from sulphate solutions. Accordingly in one experiment layers of copper from a cyanide solution were interdeposited between the layers from the sulphate solution. As seen in Fig. 4, the structure of the "sulphate copper" deposits is affected in just the same way, but not to so marked a degree, by the layers of "cyanide copper" as by nickel. No tensile strength tests were made on this deposit, but there is no reason to doubt that the change in structure was accompanied by an increase in strength.

APPLICATIONS

The possible applications of this process may extend to many operations in which the presence of another metal or of layers of the same metal is not objection-



FIG. 3. STRUCTURE OF ALTERNATE DEPOSITS OF COPPER AND SILVER ($\times 500$)

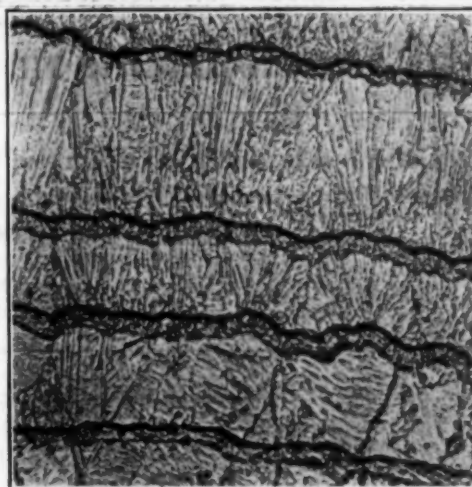


FIG. 4. STRUCTURE OF ALTERNATE DEPOSITS OF COPPER FROM SULPHATE AND CYANIDE SOLUTIONS ($\times 500$)

able. Copper is especially adapted to galvanoplastic operations, such as electrotyping, the reproduction of engraved plates, the manufacture of phonograph records, and of tubes and other irregularly shaped articles. In all of these processes the introduction of nickel layers may be found advantageous, in producing greater strength, and permitting the use of higher current densities, and possibly of thinner deposits.

Of even greater interest than the immediate industrial application of this principle is its possible bearing upon other problems in electrodeposition. If macroscopic layers of one metal produce such a decided effect upon the structure of the layers of another metal, it is entirely reasonable to expect that if the layers were much thinner, and ultimately molecular, still more marked effects would be produced. In other words, we would expect an electrodeposited alloy to have a much finer crystalline structure than either of its constituents deposited under similar conditions. This has been recently found by the author and his associates to be the case with lead-tin alloys.¹

Similarly it is known that even small amounts of foreign metals in deposited metals, arising either from accidental impurities or from intentional additions to the bath, may exert profound effects upon the structure of electrodeposits. It appears reasonable to assume that at least part of their effect is due to hindering the normal crystal growth in the above described manner. Thus viewed, these observations are at least in general accord with the theory of the "wandering diaphragm moving boundaries" as proposed by Engelhardt,² according to which the effect of colloids is caused by their migration to the cathode, accumulation upon points of (momentarily) highest current density and consequent retardation of crystal growth at those points. The whole question presents a fascinating subject for investigation, and emphasizes the importance of a more extended study of the internal structure of electrodeposits.

The author is indebted to his associates, especially W. E. Bailey, H. E. Haring and L. D. Hammond, for assistance in the preparation and study of the plates described in this paper, and to H. S. Rawdon for the preparation of the photographs.

¹W. Blum and H. E. Haring, "The Electrodeposition of Lead-Tin Alloys," *Trans. Am. Electrochem. Soc.*, 1921, vol. 40.
²*Trans. Am. Electrochem. Soc.*, 1912, vol. 21, p. 332.

Recent Developments in the Sulphuric-Acid Industry—III*

A Survey of Novel Features in Design and Operation of Recently Developed Equipment for Nitration Process Plants, Including Acid Eggs, Mechanical Acid Pumps, Tank-Car and Storage Tank Unloading Devices, Acid Valves and Gas Fans

By ANDREW M. FAIRLIE
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IT IS the purpose of the present paper to discuss, in the light of recent advances, a few of the accessories of a modern nitration process acid plant, with especial attention to the types of acid eggs, pumps and valves, gas fans and acid coolers which have been developed in recent years.

Acid eggs have been for many years the established means of elevating acid to the tops of towers. The deficiencies of the eggs have long been recognized. The power cost is high; they require the constant attention of an operator, involving the expense, day and night, of pumper's wages; the eggs must be placed several feet below the supply tanks, which means the acid must be permitted to flow to a lower elevation than necessary otherwise; the acid must be delivered into a "splash-egg" above the top tanks, which means that all the acid pumped must be elevated higher than necessary otherwise; the supply line must have a check-valve, which is troublesome, or a hand valve, which is worse; the operation of the eggs is intermittent, involving fluctuations in the depth of acid in the top tanks, and fluctuations in the quantity fed into the towers per unit of time; there is much wastage of compressed air; and the violent escape of acid mist in the tower house damages tanks, floors and roofs.

Some improvement in these conditions was brought about by the appearance of the Bihn-Jones automatic air device, first marketed by the Schutte & Koerting Co., of Philadelphia, in July, 1915. By means of this device, shown in Figs. 17 and 18, the pumper could be eliminated part of the time, the wastage of compressed air was diminished, and the splashing at the top tank was reduced to almost nil. The valve is applicable to use with any flowing liquid, but its chief use, as developed, has been for circulating the acids over the towers in chamber-process sulphuric-acid plants.

Referring to Figs. 17 and 18, this air device is composed of:

First, a base (V), which contains a seat (L), to which a number of ports for the admission of compressed air lead from an air chamber, which completely surrounds the seat.

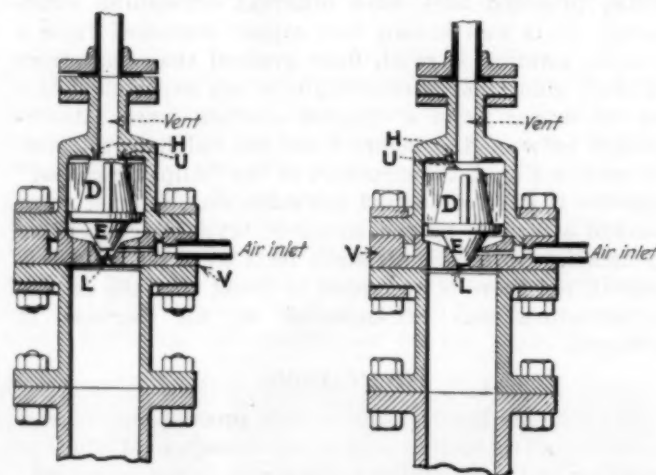
Second, a plunger (D) having a conical seat (E) on its lower surface, which contacts with the seat (L) in the base, thus completing the compressed air valve. There is also a flat circular exhaust valve seat (U) on the upper surface of this plunger.

Third, a hood which is bolted to the base, thus forming a cover for the apparatus, and a cylinder in which the plunger (D) moves. This hood contains an exhaust port, which connects with a vent pipe. Around the exhaust port of the hood there is formed a flat circular

seat (H), which contacts with the seat (U) on the upper surface of the plunger (D), and thus completes the exhaust air valve.

The operation of the device can best be understood by considering the arrangement shown in Fig. 19.

Liquid from a supply tank (A) flows by gravity through a check valve (C) into the blow-case (J) and rises until it reaches the base of the plunger (D), (Fig. 18) of the automatic air device (F), which it raises slightly, permitting compressed air to enter. The sudden release of the compressed air forces the plunger upward against its upper seat (U), thus closing the exhaust valve to the vent pipe (Fig. 17). The air thus prevented from escaping exerts its pressure on the top of the liquid, closes the check valve (C) and forces the liquid through the discharge pipe (G) to its destination. When the surface of the liquid falls below the



FIGS. 17 AND 18. BIHN-JONES AUTOMATIC AIR DEVICE
Fig. 17—Showing blow-case pumping. (Note raised position of plunger D.)
Fig. 18. Showing blow-case filling. (Note lowered position of plunger D.)

opening of the discharge pipe at the bottom of the blow-case, the compressed air follows the liquid out through the discharge line (completely clearing it of liquid), and escapes momentarily at the upper end of the line. The expansion of the air in the blow-case, due to the decreasing load as the liquid is forced out of the discharge line, causes a reduction in pressure in the blow-case sufficient to permit the plunger of the air device to drop into its lower seat by its own weight. This simultaneously closes the ports of the compressed air valve and opens the exhaust air valve, thus releasing the exhaust air in the blow-case. The check valve (C) now opens due to the head of the liquid in the tank (A) and the blow-case begins to fill, thus repeating the operation.

During the filling of the blow-case the exhaust air

*For Parts I and II see CHEM. & MET. ENG., vol. 25, Nos. 19 and 20, pp. 861 and 917, Nov. 9 and 16, 1921.

or gas which remains after pumping is displaced by the incoming liquid and escapes through surge-holes in the base of the air device, passes through openings at the side of the plunger and escapes through the exhaust port and the vent pipe (I) (Fig. 19). Fig. 17 shows plunger D in the raised position while the egg is pumping, and Fig. 18 shows plunger D in the lowered position while the egg is filling.

The manufacturers have recommended the use of

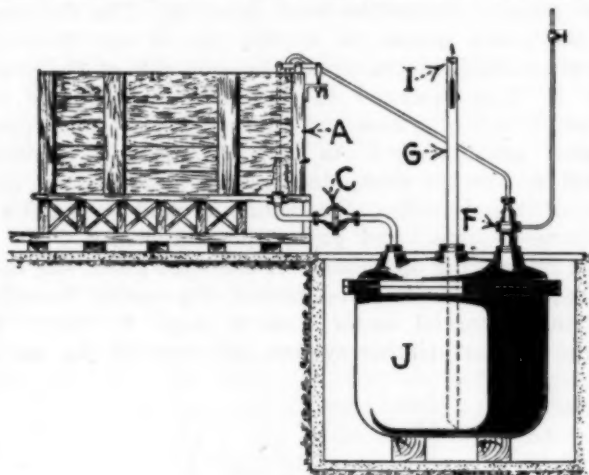


FIG. 19. AUTOMATIC VALVE MOUNTED ON ACID EGG AND CONNECTED TO ACID SUPPLY TANK

small eggs in combination with the Bihn-Jones equipment. However, it has been found in practice that the use of very small eggs with this device results in a very frequent up-and-down movement of the plunger, with resultant excessive wear on the seats. The result of this has been undue expense for mechanical repairs to the air device, which tends to offset to some extent its advantages. Where the egg is of reasonable capacity (4 tons 60 deg. acid or more) and the quantity of acid to be pumped is moderate, this device has proved to be a real asset. As the device, with its small air ports, reduces somewhat the normal speed of filling and discharging the egg, it may not be suitable for pumping very large tonnages of acid.

At the plants of the Tennessee Copper Co., where the quantity of circulating acid is exceptionally large, the supply and discharge lines for the eggs are of wrought iron, the former being 6-in. pipes, and the latter 4-in. At these plants the usual lead splash eggs at the top tanks have been replaced by cast-iron splash eggs, which have proved much more durable and less expensive to maintain.

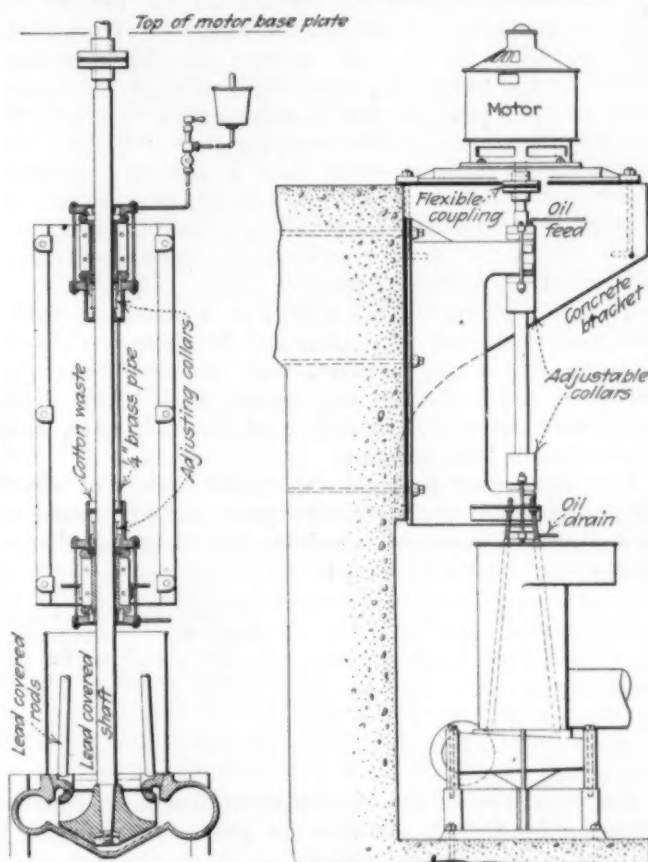
On account of the deficiencies of the acid eggs, many attempts have been made to develop a satisfactory mechanical acid pump. These attempts have for the most part had negative results until recently. A number of acid pumps are now on the market, each with its peculiar claims to merit and each with its deficiencies. Four of these will be briefly described.

The Antisell pump, manufactured by the Chemical Pump & Valve Co., is of the packingless type, and the horizontal impeller, attached to a vertical shaft, is submerged in a body of acid at the bottom of a boot having a supply pipe directly connected to the supply tank.

Fig. 20 is a vertical section through one of these packingless pumps. This particular pump was designed to handle sulphuric acid against a head of 100 ft. with an efficiency of 45 per cent. The acid by gravity

enters the boot surrounding the vertical shaft and proceeds to the pump impeller through the annular opening in the pump cover. The acid itself thus forms a perfect seal against the admission of air and dispenses with the troublesome packing glands and packing of horizontal-shaft pumps.

Fig. 21 shows a type of lead packingless pump designed for handling solution containing 24 per cent sulphuric acid at the rate of 3,500 gal. per minute against a head of 40 ft., developing an efficiency, it is claimed, of 73 per cent. A distinct advantage of this make of pump is that any element of the pump may be taken apart for cleaning, repairs or renewal without disturbing the adjacent parts of the pump or disconnecting feed or discharge lines. The manufacturers state that the actual time required to change an impeller is less than 1 hour. The figure illustrates one of twenty pumps furnished the New Cornelia Copper Co., of which it is



FIGS. 20 AND 21. TWO VIEWS OF ANTISELL PACKING-LESS PUMPS

Fig. 20. Vertical section of pump.

Fig. 21. Special pump designed for handling dilute acid in large quantities.

stated that several have operated for 3 years without repairs. The acid pumped, however, was, as stated, weak and probably cold. In this pump the packing trouble inherent in all horizontal-shaft pumps has certainly been eliminated, the parts of the pump are easily accessible for replacement or repair, and the capacities claimed for the pump have been realized. Possible objections to the pump may be that the power efficiency is less than with the packed pumps, that the expense of installation, with massive concrete pillar, is excessive, and that the long overhang, without bearings at bottom of shaft to keep the revolving impeller in alignment, may result in undue vibration or excessive wear on the bearings and other parts of the pump.

The Ceco pump was first used in the chemical indus-

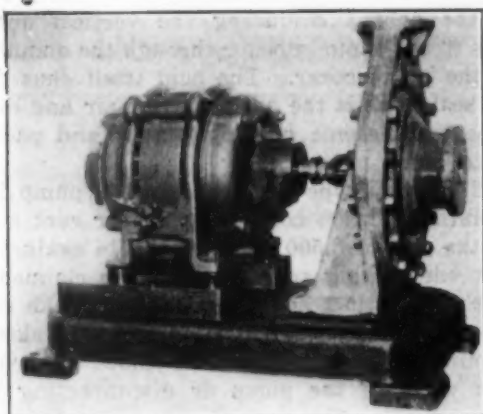


FIG. 22. CECO ACID PUMP WITH DIRECT-CONNECTED MOTOR

try in connection with the manufacture of phosphoric acid in the plant of the Victor Chemical Works, at Chicago Heights, Ill. On account of the corrosive nature of the phosphoric acid, together with the heavy scale which formed in pumps, valves, pipe lines and all other equipment in use for handling the crude acid, the conveying of this material was a difficult problem. After a thorough trial of the pump all other means of conveying phosphoric acid at this plant were abandoned, and it is said that this company has at the present time more than 100 of these pumps in use.

The first pump of this type was installed in 1914. The manufacturers (the Chemical Equipment Co., of Chicago, Ill.) state, however, that the pump was not perfected and put upon the market until 1918. The pump was patented under date of Oct. 19, 1920, and other patents are pending.

Ceco pumps are made of antimonial lead or of other alloys, according to the requirements, and are made in four standard sizes, with suction and discharge diameters respectively as follows:

Size	Suction Diameter, In.	Discharge Diameter, In.
A.....	1.5	1.0
B.....	2.0	1.5
C.....	2.5	2.0
D.....	3.0	2.5

The capacities of the several sizes depend of course upon the head against which the pumps are working.



FIG. 23. CECO ACID PUMP SHOWING SUCTION HEAD REMOVED

The pump can be arranged for either belt drive or for direct-connected motor as in Fig. 22.

While the Ceco pump is generally classified as a centrifugal pump, it might more properly be termed a displacement pump, inasmuch as there is no volute, and the liquid is merely forced out of a center compartment, or pressure chamber, into an annular space of uniform cross-section, or discharge chamber. These two chambers are clearly shown in Fig. 23, a photograph of a Ceco pump with suction head removed. The discharge of the pump proper is at the top of the discharge chamber, which slopes equally to each side of the pump, and is thus designed to eliminate pockets for the accumulation of gases and to render the pump proof against gas-binding. As long as there is sufficient liquid within the pump to seal the clearance on each side of the impeller, the pump is said to handle a mixture of liquid and gas without difficulty.

An interesting application of the Ceco pump has been made possible by the development of a special "priming system," patented under date of Sept. 2, 1919. By means of this priming system and without the use of

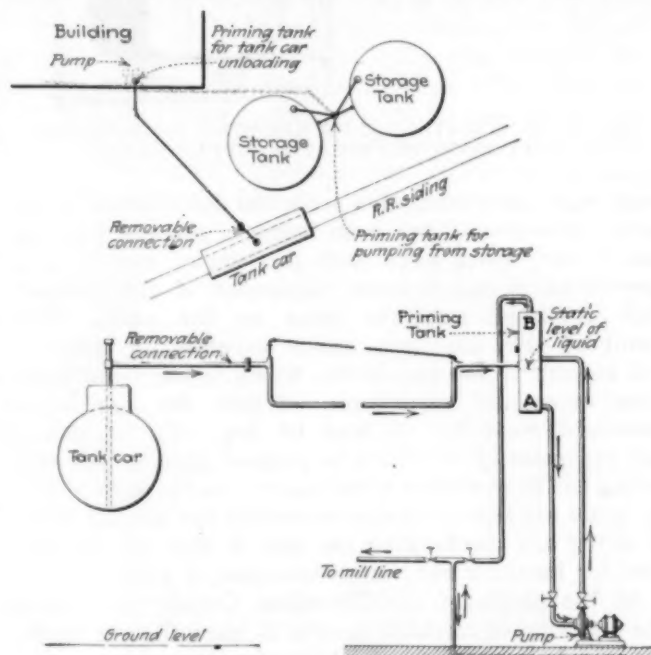


FIG. 24. DIAGRAM OF PRIMING SYSTEM FOR UNLOADING TANK CARS OR STORAGE TANKS

check valves or other moving parts, the pump with primer attached will withdraw acid through the dome of tank cars or storage tanks, thus dispensing with the need of bottom outlets. The greatest vertical distance that acid of 60 deg. Bé. can be lifted by means of the suction effect of the priming system is 16 ft. After entering the pump the acid can be elevated, by pump pressure, a vertical distance of 40 to 90 ft. more, according to the capacity of the pump used. Fig. 24 is a diagram of a priming system for unloading tank cars. Referring to this drawing, tank B is superposed above tank A, and these two tanks are called the priming tanks. A pipe connects the upper part of tank A with a tank car, and another pipe connects the lower part of tank A with the pump. The discharge of the pump is connected by a pipe with the bottom of tank B, and from the top of the latter another pipe conveys the acid to any place desired.

When this apparatus is first installed, tank A is

first filled with acid to the static level just below the discharge end of the suction pipe from the tank car. On this pipe a suction effect is produced by the act of starting the pump, caused by the emptying of the contents of tank A by gravity into the pump. This suction effect pulls the acid out of the tank car, through a pipe inserted through the dome, and the outflow of acid continues until the tank car is emptied. When this happens, air enters the pump and the pumping operation ceases. The pump is then stopped, and the acid flows from tank B through the pump into tank A, whereby the latter is automatically primed for unloading the next tank car.

Another use for the primer is in connection with the withdrawal of acid through the dome of deep storage tanks. Wherever the acid manufactured contains much sediment, which may be allowed to settle to the bottom of the storage tank and leave a body of clear supernatant acid, this device may prove useful in withdrawing the latter for shipment without disturbing the sediment at the bottom of the tank.

Acid pumps made of antimonial lead are open to the objections that the metal is relatively soft, is readily corroded by sulphuric acid and nitrous vitriol, and is subject to erosion by the particles of scale or other solids held in suspension by the acid, and thus the life of the lead pumps is comparatively brief. Duriron is well known to the chemical industry as a hard, brittle metal, much more resistant to the corrosive and erosive actions of acids than any of the lead alloys. Duriron acid pumps have been on the market for a number of years, but they have never come into general use for circulating acids over Gay-Lussac and Glover towers, due, no doubt, to the trouble experienced in keeping the stuffing box suitably packed.

In June, 1920, a Duriron acid pump of new design was placed on the market by the Duriron Co., Inc., of

However, if the pump should be stopped without first closing a valve at the bottom of the discharge line, it is likely that here, as with all other horizontal-shaft pumps, some acid might enter the stuffing box and cause slight leakage. The pump is furnished for either direct-connected motor or for belt drive.

Fig. 26 shows the belt-driven type of pump. The capacity of this pump is stated to be 20 tons 60 deg. Bé. acid per hour at a head of 80 ft., with power consumption of less than 7 hp.

The speed of the pump can be regulated to deliver any quantity up to the maximum capacity. After removing the cover plate from that side of the pump opposite the stuffing box, the runner and shaft can be removed without disconnecting either the inlet or the outlet pipe. The shaft is of machine steel, and is covered by a Duriron shroud projecting through the

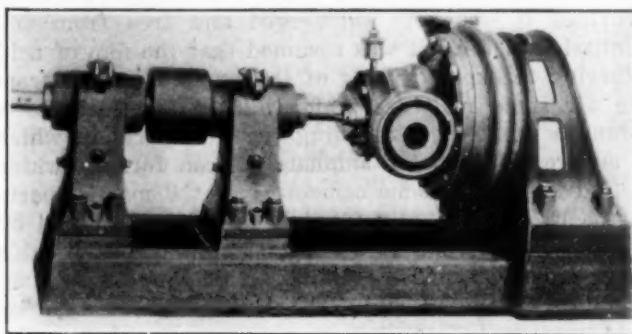


FIG. 26. DURIRON CENTRIFUGAL PUMP FOR BELT DRIVE

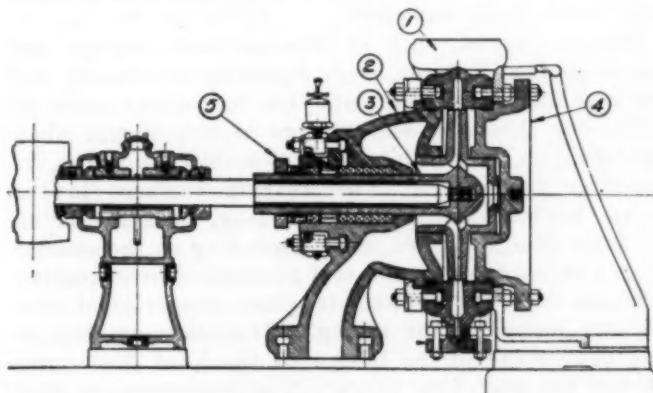


FIG. 25. ASSEMBLY DRAWING OF DURIRON CENTRIFUGAL PUMP

1—Volute. 2—Suction elbow. 3—Runner. 4—Pump cover. 5—Packing gland.

Dayton, Ohio. The main features of this pump are: (1) Packing under slight vacuum while pump is in operation. (2) A helical impeller. (3) Accessibility of revolving parts without disturbing either suction or discharge line. (4) Rotatability of both volute and suction elbow to any position desired, in order to fit existing pipe lines.

Fig. 25 shows an assembly drawing of this new centrifugal pump, with 2-in. suction line and 1.5-in. discharge. In this pump it is claimed that the packing cannot be touched by the acid while the pump operates, inasmuch as the stuffing box is under a slight vacuum.

stuffing box. A web, cast between the top of the volute and the discharge flange, is designed to permit the escape of trapped air and prevent air-binding.

The Lewis centrifugal acid pump, like the Antisell pump, is a vertical packingless pump. The primary business of its manufacturers, the Charles S. Lewis Co., of St. Louis, Mo., was the manufacture of pumps for the circulation of cooling water or brine in refrigerating systems. The company's first pump for the elevation of acid was built in the early part of 1913. It was designed for pumping 60 deg. acid from the base of a Glover tower to the tank on top of a Gay-Lussac tower, and all parts were of cast iron except the shaft and casing bolts, which were of steel and wrought iron, respectively. This pump, of the vertical submerged type, was driven by a direct-connected motor. Fig. 27 is a photograph of this unit. This pump had 2-in. pipe connections, and, driven by a 4-hp. vertical motor, was good for a head of 70 ft. when pumping 60 deg. acid. It is now obsolete.

The principal features aimed at in designing this pump are listed below in the order of their importance: (1) Elimination of stuffing boxes and packing. (2) Production of a self-contained unit capable of being completely assembled in perfect alignment before installing at the acid plant. (3) Reliability and durability. (4) High power-efficiency. The first of these conditions was wholly satisfied by this first submerged pump. The acid entered the pump at the center on the upper side and was discharged below at the side. The second condition was also satisfactorily met. The pump was assembled and connected to the motor by means of the cast-iron frame which tied the pump to the main plate supporting the motor. The fourth condition was also complied with by this pump (which was a two-

stage machine), inasmuch as the power efficiency, with the pump delivering 10 tons per hour against a head of 70 ft. with power consumption of about 2.5 hp., was computed to be 45 per cent.

The third condition—reliability and durability—was the only one which this first pump did not fully satisfy. The pump discharged more acid than was being fed to its supply tank, with the result that it pumped all the acid out of the lower tank and drew considerable air into the impeller. Then the pump was shut down to install a throttle valve, and the next day, on attempting to start it, the impeller was found to be firmly cemented to the stationary parts of the pump. In trying to loosen the impeller, several of the small internal parts were broken and had to be replaced, and the pump then operated satisfactorily. Further experience showed that the pump could be stopped and permitted to stand for some time, without its sticking, provided it was kept submerged and free from any admission of air. It was assumed that the film of acid adhering to exposed parts of the pump absorbed from the air some moisture which diluted that acid to a strength capable of corroding the iron parts to which it adhered, and that a sulphate of iron formed, which caused the troublesome cementing of the moving parts to the fixed parts. By carefully excluding air and by keeping the acid up to 60 deg. strength, very reliable service was obtained, and it is said that this pump would do continuous duty 24 hours a day for eight or nine months before it was necessary to change the impeller or repair internal parts.

The development of the Lewis pump of today has proceeded from this original design. By placing a sub-

The new design was a single-stage pump, and it was found that the additional power required to operate it on the same duty as the former two-stage submerged pump was more than compensated for by simplicity of assembling and repairing. Fig. 28 shows the present type of Lewis centrifugal pump with 5-hp. direct-connected motor, embodying these improvements.

No attempt was made by the Lewis company to handle acid weaker than 60 deg. Bé. until 1916, when it built its first hard lead pump. The main difficulty to be overcome was to find suitable material for guide-bearings at the lower end of the shaft, which the

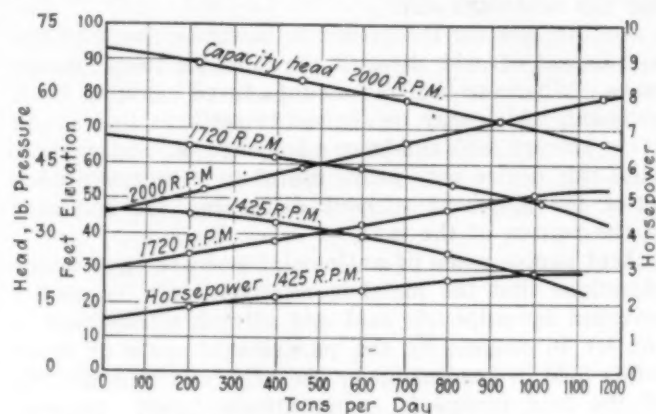


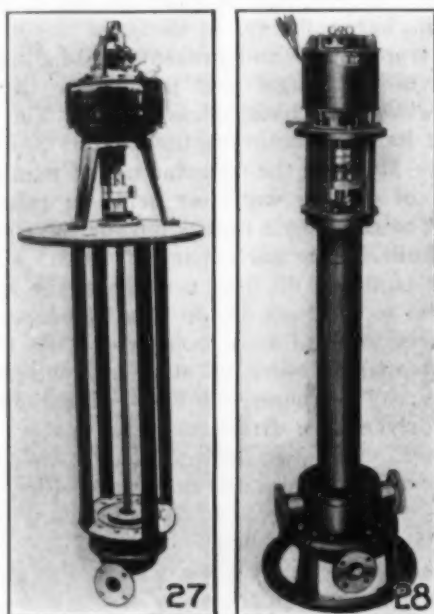
FIG. 29. PERFORMANCE CURVES FOR LEWIS PUMP HANDLING 60 DEG. ACID

company considered desirable, to hold the shaft and impeller true and free from vibrations. The problem was finally solved by Duriron bearing bushings in the lead pump casing, and by covering the shaft, at the parts revolving within these bushings, by Duriron sleeves. These Duriron bushings and sleeves were ground and polished to obtain adequate bearing surfaces. The lubrication afforded by the acid pumped was found to be sufficient.

Other obstacles, such as unsound lead castings and coarse-grained Duriron, were gradually eliminated, and the manufacturers now state that indications point to a life for the hard lead casings of this pump, when operating on weak sulphuric acid or nitrous vitriol, of three or four years. The wearing surfaces in the pump, however, do not last that long, their life being from six months to two years, depending on the amount of grit or sediment in the acid pumped. These wearing surfaces can be renewed at small proportional cost without renewing the casing. Practically no change has been made in the design of the hard lead pump during the past four years. The improvements have been confined to the quality of the materials entering into the parts of the pump.

In Fig. 29 are given performance curves showing capacity and head at various speeds, also brake horsepower. The curve shows that the pump will deliver 400 tons per day against a 62-ft. head equal to 46 lb. pressure when operating at a speed of 1,720 r.p.m. The horsepower required is 3.8.

The outstanding feature distinguishing this pump from the Antisell pump lies in the centering of the lower part of the shaft in fixed guide bearings. This very feature, while it keeps the shaft always in perfect alignment, exposes the pump to the criticism that these guide bearings have to be frequently renewed. The internal parts are rather inaccessible. To get at them the pump has to be completely dismantled and turned



FIGS. 27 AND 28. LEWIS ACID PUMPS

Fig. 27. Vertical submerged type (now obsolete).

Fig. 28. Modern type vertical acid pump for direct-connected motor.

stantial cast-iron boot around the acid inlet to the pump, the submerged pump has been converted into an outside vertical pump without losing any of the advantages of the submerged type and with the advantage gained that only the internal surfaces of the pump are exposed to acid, all bolts and nuts being kept on the outside, free from acid corrosion.

over on its side. The maintenance cost of these pumps, given by the manufacturers as about \$24 per month per pump, is high as compared with the maintenance cost of acid eggs. The net saving, however, due to lower pumping costs for power and operating labor, is said to more than compensate for the higher repair costs.

A number of new acid valves have been developed since 1914, and among these three important types will be discussed.

As was the case with the Ceco pump, the Ceco valve

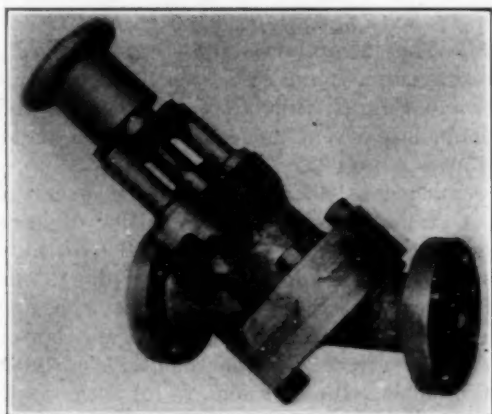


FIG. 30. CECO ACID VALVE ARRANGED FOR STRAIGHT-WAY CONNECTION

was developed at the plant of the Victor Chemical Works, Chicago Heights, Ill., because of the difficulty experienced by this company in finding on the market a valve suitable for contact with crude phosphoric acid. In designing this valve, the features aimed at were:

- (1) A removable seat which could be withdrawn without disconnecting the entire valve and which could not corrode in place.
- (2) A seat which would not accumulate scale.
- (3) Flexibility as to angle of installation.
- (4) Operating mechanism inaccessible to acid or acid fumes.
- (5) A packing gland without studs.

Fig. 30 is a photograph of a 3-in. valve of this type, and it is seen to be of peculiar design. The removable seat is made of a flat slab of metal held in place between two flanged faces on the valve body. The seat is identical as to shape on both sides, thus making it reversible, and it can be removed without disconnecting the valve from the line. Only a few minutes are required to reverse or replace a seat.

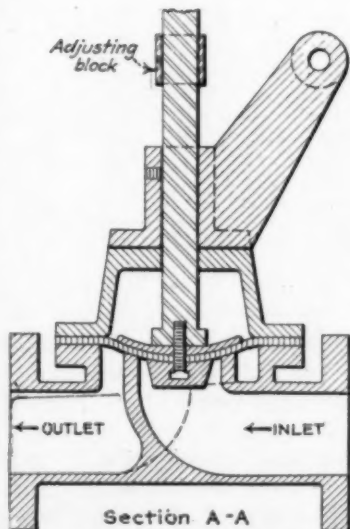
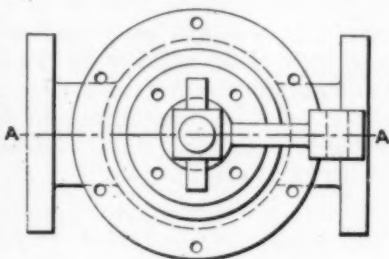


FIG. 31. SECTION AND PLAN OF PACKINGLESS VALVE

In the ordinary valve, a tapered plug fits into a tapered seat, and any accumulation of scale or sediment on either plug or seat prevents effective closing of the valve. In the Ceco valve, the hole within the slab seat is cylindrical, and on a new valve the seating edge is quite sharp. Even after a valve has seen considerable service, the manufacturers claim, the seating is virtually a line contact. This means a minimum of area for the deposit of scale or sediment, and if scale does form on either of the seating members, it is said that the act of closing the valve tends to break away the scale. To prevent sticking of the plug, a relieving taper is provided thereon. A taper is machined also on the upper side of the plug, and at the top of the valve body another seat is machined, so that when the valve is wide open, the upper part of the plug is again seated on a line contact, the object being to seal the stuffing box against leakage, and permit the repacking of the valve while under pressure.

In order to broaden the scope of application of this valve to service, the body of the valve is divided into two parts at an angle of 45 deg. This permits of assembling any valve in either a straight or an angle position. Thus, using the same valve parts, the straight-way valve shown in the figure can be changed into a right-angle valve by turning that part which is on the left of the removable seat 180 deg., so that the valve stem and handle are below the left-hand flange, instead of above it.

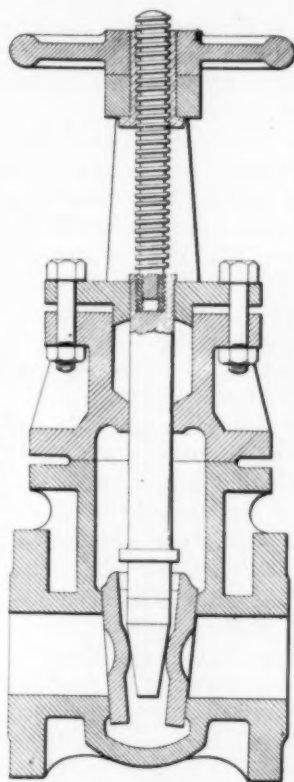


FIG. 32. SECTION OF DURIRON GATE VALVE

Fig. 31 is a section and plan of a float valve of the packingless type manufactured by the Chemical Pump & Valve Co. The valve is provided with a flexible diaphragm which walls off the acid from the bearing of the valve stem. There is consequently no need of a stuffing box or packing. The flexible diaphragm is of lead, if the valve is to be used with sulphuric acid. The manufacturers state that owing to the limited movement of the diaphragm, the valve may be opened many hundreds of times before the lead cracks. When the lead does crack, it becomes necessary to drain the line, open the valve and put in a new diaphragm. It should be noted that owing to the design of the valve, the line cannot be drained unless the valve, when installed, is placed on its side. This valve is made in all sizes from 1 in. to 18 in., the capacity of the latter being 5,000 gal. per minute.

Fig. 32 shows a section of a Duriron gate valve which was first put on the market in June, 1920. It is a valve of the rising stem type. As the metal is highly resistant to corrosion, it is claimed that this valve will not stick under the most trying conditions. Gate valves of the ordinary type are inefficient as a positive shut-off for acid, particularly if the acid handled contains solids in suspension. This valve has double-hinged disks which

the manufacturers claim afford positive closure on both seats, and the valve can be used against pressure from either direction. The wedge action of the stem eliminates any wear on disks or seats, and the valve is so positive in its action that it is said to be useful with gases as well as with liquids. The valve can be packed while under pressure.

LARGE GAS FANS

The construction during the war of acid-making units of large capacity led to a demand for larger gas fans. This demand was recognized by the Pratt Engineering & Machine Co., of Atlanta, Ga., which in 1918 developed a fan which has a rated capacity of 15,700 cu.ft. of free air per minute against a pressure of 1.75 in. water gage, at a speed of 450 r.p.m. This compares with a rated capacity for the company's next largest fan of 10,000 cu.ft. per minute against the same pressure, at a speed of 560 r.p.m. The large acid plant built for the Government at Little Rock, Ark., was equipped with the larger Pratt fans. A large capacity acid-gas fan is also manufactured by the Buffalo Forge Co., Buffalo, N. Y., and has been on the market for some time. The Schutte & Koerting Co., Philadelphia, has designed some improvements to its acid-gas fan, and the new model was first marketed in 1916. The features distinctive of the new type are: (1) A blast wheel webbed so as to close entirely the spaces between blades at the side opposite the gas intake, the webbing being continuous from tip of blade to hub. (2) A blast wheel housing, cone-shaped at the side opposite the gas intake, so as to conform to the shape of the webbing between fan blades, and with smallest practicable clearance between webbing and cone-shaped part of housing, from tip of blades to hub.

This new model, like the Pratt and Buffalo fans and like most other fans designed for use beyond the Glover tower, is made of antimonial lead. On account of the low tensile strength and relatively low resistivity to corrosion by acid gases of this alloy, the need has long been felt for a material, applicable for use in the blast wheels and housings of acid plant gas blowers, which would be more durable in service. The Duriron Co., of Dayton, Ohio, has endeavored to supply this need with a Duriron fan, first marketed in January, 1920. It is made as yet in small sizes only, from 3 in. to 12 in. The 12-in. fan is said to be able to handle all the gas produced by burning 17 tons of sulphur in 24 hours, and can be operated safely at a speed of 1,800 r.p.m.

The impeller wheel will withstand erosion as well as corrosion, and the manufacturers recommend it for handling gases containing solid particles in suspension. Wherever this fan is used, the brittleness of the metal must never be overlooked, in tightening bolts or in moving the runner or the cap. One moment's carelessness in handling Duriron shapes has often caused the instant destruction of an expensive casting.

CAPACITY OF GAS FANS

Considerable uncertainty is found among sulphuric-acid manufacturers regarding the actual capacity of the various types of acid-gas blowers for moving gases. The capacity figures quoted by the blower manufacturers are received with a great deal of skepticism. It appears that the matter of determining the true capacities of the blowers for moving acid gases at the temperatures of such gases in an operating plant, and making due deductions for such items as air leakage at the shaft, steam coming over from the Glover tower with the gas,

etc., has not been attacked by the blower manufacturers in the scientific and convincing way which the problem deserves. To determine the capacity of a blower for delivering free air is a difficult problem in itself. To determine the capacity of a blower for moving hot moist acid gases is more difficult still. The problem should not, however, be neglected, and the sooner the blower manufacturers begin to determine scientifically the real acid-gas-moving capacities of their machines the sooner may the industry expect improvement in their efficiency.

IMPROVEMENTS IN ACID COOLERS

No recent developments of merit in acid coolers have appeared. The large rectangular acid coolers of the Calumet & Arizona Mining Co., described and illustrated by Wells and Fogg,¹² while they conserve ground space and accommodate a very large linear length of lead pipe which affords a high area of external cooling surface, are not regarded as efficient coolers. In order to avoid regions of stagnant acid within a cooler of such large dimensions (capable of containing 5,000 linear ft., or nearly one mile, of 1½-in. coiled lead pipe), numerous baffle walls, dividing the cooling tank into numerous small compartments, and alternate top and bottom acid outlets between adjacent compartments, are needed, thus forcing the whole volume of acid, in its progress through the cooler, to take an alternate up and down movement along the vertical length of each coil, and come into direct contact with a maximum area of water-cooled lead pipes. The manner of connecting the coils to obtain a counter-current flow of water to acid needs special study.

Atlanta, Ga.

(Part IV will appear in a subsequent issue.)

Imports of Iron and Steel From Europe

Up to the end of August United States imports of iron and steel from Europe this year have aggregated 17,104 tons. More than 60 per cent of the total has been pig iron and semi-finished steel, with bars and sheet and plates making up the bulk of the remainder. Belgium alone sent nearly 60 per cent of the imports.

The following table shows in detail how the different products imported were divided among the various countries of origin.

IMPORTS OF IRON AND STEEL FROM EUROPE, EIGHT MONTHS OF 1921

Articles	All Europe, Tons	Belgium, Tons	Sweden, Tons	United Kingdom, Tons	Germany, Tons	Czechoslovakia, Tons	France, Tons	Other, Tons
Pig iron.....	7,896	7,191	130	400	125	...	50	...
Billets.....	2,736	2,422	265	...	48	...	...	1
Steel bars.....	2,685	348	1,171	588	141	344	35	58
Sheets and plates.....	1,867	100	113	1,367	281	3	3	...
Iron bars.....	1,103	128	910	53	3	...	...	...
Wire rods.....	502	...	466	26	1	6	1	2
Tin plate.....	276	...	...	276	...	...	...	...
Structural steel.....	39	...	...	8	31	...	...	...
Total.....	17,104	10,189	3,055	2,718	630	362	89	61

Belgium has been the chief factor in supplying pig iron and billets, but other lines from Belgium have been relatively unimportant. Sweden has been strongest in imports of bars and wire rods, and the fact that Sweden stands next to Belgium in total tonnage has not generally been recognized by current reports regarding competition of European steel in domestic markets.

¹²Op. cit., pp. 116, 121.

Pulverized Coal in the Iron and Steel Industry

BY F. P. COFFIN
General Electric Co.

THE principal application of pulverized coal in the iron and steel industry are for the following classes of furnaces:

Heating furnaces:

- Heating, reheating and forging.
- Continuous heating, for blooms and billets.
- Annealing malleable iron and steel castings and plates.
- Sheet and pair (steel bars are heated for rolling into pieces).
- Busheling and puddling (malleable iron).
- Tin pots.
- Galvanizing pots.

Melting furnaces:

- Open-hearth steel.
- Malleable iron.

For rough work the fuel is often burned in the same compartment with the work. For more finished work, where ash and slag may have a deleterious effect, a separate combustion chamber is frequently provided, and the two compartments are separated by a low bridge-wall. A large part of the ash collects in the bottom of the combustion chamber while the flame plays over the bridge-wall, and is long enough to extend over the work and to heat it by direct radiation. When substituted for natural gas, increased thermal efficiencies have been attained owing to the greater proportion of radiant heat emitted by the flame.

TYPES OF FURNACES

In small forging furnaces the coal and air are sometimes introduced through opposed tuyeres in order to avoid the impingement of the flame on the wall opposite the burner. A typical small forging furnace is shown in Fig. 1. This is equipped with opposed tuyeres and the secondary or volume air is divided between the two, while the coal is fed into one side only, being carried by the primary air which forms a small proportion of the air required for combustion. When warming a cold furnace, a hot spot is visible where the blasts impinge. As the brickwork becomes heated, this spot fades to a uniform glow which fills the whole interior. It is claimed that the introduction of all the coal on one side gives the best results. This furnace is located in the drop forge shop of the American Locomotive Co., in Schenectady, N. Y.

One of the most modern installations for burning pulverized coal in a sheet-rolling mill is to be found in the plant of the Newport Rolling Mill Co., at Newport, Ky.¹ Natural gas was formerly used as fuel.

The output, when burning pulverized coal, so greatly exceeded expectations that it was only necessary to re-equip six furnaces to handle the same output as eight stoker-fired annealing furnaces of the same size.

The following figures have been submitted as average production data attained at the plant: On the slab-heating furnaces, maximum fuel consumption of 180 lb. of coal per ton of product, though it is stated that considerably less than this amount per ton may be

taken as the average run. On the sheet and pair furnaces, fuel consumption covering long periods has not exceeded 275 lb. of powdered coal per ton of sheets produced. On the annealing furnaces, fuel consumption using powdered coal is reported well under 170 lb. of coal per ton of sheets annealed. On the galvanizing pots, fuel consumption below 110 lb. per ton, on the average, and considerably less than this average for favorable weight sheets.

Furnaces for melting and refining steel by the basic open-hearth process are fired with pulverized coal in a number of plants. A furnace of this type is shown in Fig. 2, equipped for firing with pulverized coal by the Bonnof system. The practice is to fire the fuel from both sides of the furnace on the reversing principle with a high velocity blast. In some installations the air required for combustion is delivered to the burner at a pressure of 1 lb. per sq.in. by a centrifugal compressor, in others by a fan blower at 8-oz. pressure.

According to N. C. Harrison² of the Atlantic Steel Co., Atlanta, Ga., "the hearth of a pulverized coal open-hearth furnace is practically the same as the hearth of any other open-hearth furnace; the uptakes, slag pockets and checker chambers, however, are entirely different. The uptakes are made as small as possible so as to hold the gases in the furnace as long as possible without blowing, and the slag pockets are made as large as possible so that the gases will have a slow velocity going through them, thereby depositing a large percentage of the heavy particles that are in the outgoing gases. On account of this heavy deposit, removable slag pockets, or very deep stationary pockets, should be used to collect this accumulation. Where removable slag pockets are used, they are taken out and cleaned and replaced about every two weeks. Only one checker chamber is needed on each end of the furnace. If the checker chamber is large enough, these chambers should be built up with large tiles and laid in such a manner as to form vertical flues, having openings of at least 6 x 9 in., or, better, 9 x 11 in. In some cases no checkers are

²Consult "Pulverized Coal as a Fuel," *Mechanical Engineering*, August, 1919.

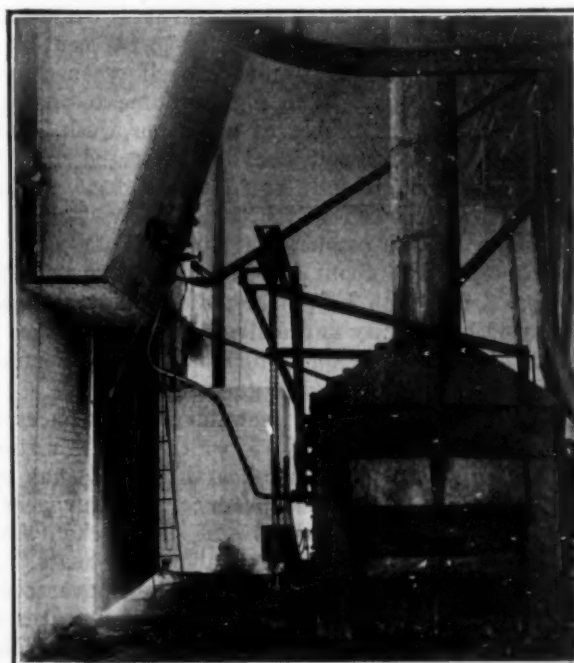


FIG. 1. VIEW OF A SMALL FORGING FURNACE WITH PULVERIZED COAL BURNER

Excerpt (by permission) from material prepared for Bacon and Hamor's "American Fuels," now in press of McGraw-Hill Book Co.

¹Consult "Burning Pulverized Coal in a Sheet Mill," *Iron Age*, Dec. 11, 1919. "Burning Powdered Coal in a Rolling Mill," by H. T. Matthew, *Combustion*, April, 1920.

used at all, but the chambers are filled with baffle walls with openings from the outside so that the accumulation between these baffle walls can be raked out. All passages from slag pockets to stack must be as straight as possible and, wherever bends must be made, some agitating device should be installed. The reversing valves are usually of the mushroom and damper slide type.

"The best coal for use in pulverized form in open-hearth practice is a bituminous coal as high in volatile matter as possible, and preferably low in ash. It should never contain below 32 per cent of volatile nor more than 8 per cent of ash. It is necessary that the coal be as finely ground as possible so that about 97 per cent will pass through the 100-mesh sieve; preferably 90 to 93 per cent, and not less than 85 per cent through the 200-mesh sieve, and from 70 to 75 per cent through the 300-mesh sieve. This is necessary for quick combustion and for the elimination of sulphur. By this very fine pulverization we attempt to have complete combustion before the flame strikes the bath, thereby burning out the sulphur in the coal to SO_2 gas, which passes up the stack. Some 6 or 8 ft. is necessary from the end of the burners to the bath.

"The advantages and disadvantages from the use of pulverized coal, as compared with hot producer gas, as

alterations we expect to get much longer life out of the checkers, and, consequently, longer runs out of the furnace. As a result of this continued development, we believe that inside of six months we will obtain a 25 per cent increase in production over the gas producer furnaces of the same size.

"Sulphur does not give any trouble as long as there is a good draft and the furnace is working hot. We are now using coal with over 1 per cent of sulphur and getting good results. If checkers get clogged up and the furnace begins to blow, due to lack of draft, we have trouble with the bath taking up sulphur. The furnace is under complete control of the first helper, as to amount of coal being used, as well as the air blast and temperature. The flame, using the same coal as on gas producer, is hotter, which allows us to use a greater percentage of scrap per ton of steel, thus reducing the consumption of high-priced pig iron; also it enables us to obtain a greater number of heats per week.

"The finished steel is quieter in the molds, due to not being overoxidized, as the coal coming directly in contact with the bath has a greater reducing action. We feel reasonably certain that the oxidation losses are less with pulverized coal than with producer gas. All gas house troubles are eliminated (clearing fires, burning-out

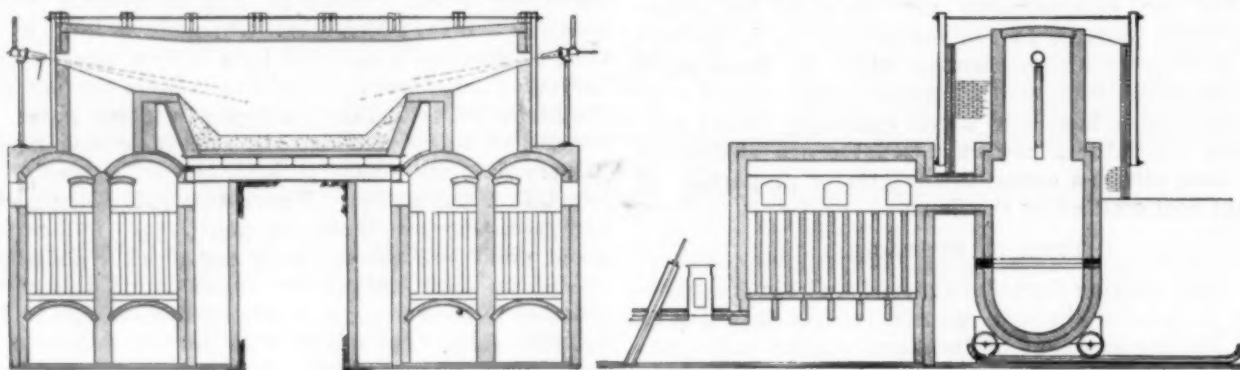


FIG. 2. TYPICAL OPEN-HEARTH FURNACE WITH PULVERIZED COAL BURNER

a fuel for open-hearth furnaces, from observation of its use up to date are as follows:

"All the heat is generated in the furnace, while in the case of the gas producer, from 18 to 25 per cent of the heat units are lost in the producer itself when converting the coal into gas. The higher flame temperature results in a greater number of heats per week. Open-hearth furnaces using powdered fuel operated on a very low fuel consumption fully equal to the best producer gas practice, and much better than the average of the older plants in this country; at the Atlanta plant the coal consumption is about one-third less than with producer gas. Coal can be pulverized in plants of about 100 tons daily capacity and delivered to the furnace for approximately 50c. per ton, which is about the same as the costs for gasifying coal in gas producers.

"The use of this fuel in metallurgical furnaces has been developed to only about 75 per cent of its ultimate value. In our plant this open-hearth furnace has been shut down oftener than the producer gas furnaces of the same size, due to checkers and slag pockets filling up with cinders and slag after about 80 heats. We believe, however, that we are gradually overcoming these troubles by decreasing the size of the uptakes and enlarging the slag pockets as mentioned above. Now, only the fine particles are going to the checkers and are being blown off daily by compressed air. By these

flues, etc.), although the pulverizing plant must be given attention as to dryness and fineness. Refractory costs have been greater on the furnace using pulverized coal than on gas producer furnaces. I believe, however, that our steadily increasing familiarity with the use of this fuel will enable us to reduce this item nearly to the corresponding cost in producer gas furnaces."

The pioneer installation for firing basic open-hearth steel furnaces was made by the National Malleable Castings Co., at Sharon, Pa., about 1914, and has been operated successfully since that time. Pulverized coal has displaced fuel oil without any sacrifice of tonnage or quality of the product and with gratifying results.¹

In some recent open-hearth furnace installations, built from designs made by the Quigley Furnace Specialties Co., vertical baffle walls have been used in the regenerative chambers in place of checkers.

A number of basic open-hearth installations have been made at plants of the United States Steel Corporation. Pulverized coal has been applied to the acid open-hearth process, but has not been found suitable.

Pulverized coal has been used in a number of malleable iron foundries for annealing castings, some of the installations dating from the earlier period when more

¹Consult also "Pulverized Coal Systems in America," by L. C. Harvey, Fuel Research Board Special Report No. 1, London, 1919. Also "Pulverized Fuel, Its Use and Possibilities," by W. J. Dick, Commission of Conservation of Canada, Ottawa, 1919.

coarsely powdered coal was used. Until recently, however, it had not been successfully used for melting purposes.

What is probably the pioneer installation for melting malleable iron¹ was made in 1919 at the malleable foundry of the General Electric Co., at Erie Pa. (Fig. 3.) This is an air melting furnace with a capacity of 10 or 15 tons and is equipped with a 22-in. burner. Considerable experimenting was necessary at first to obtain the most satisfactory arrangement and the furnace has recently been greatly simplified by discarding three features which were considered necessary at the start.

The first was a water-cooled damper, at the back bridge wall, which was thought necessary for controlling the stack draft. The second was a combustion chamber between the burner and the furnace. This was thought necessary to obtain complete combustion of the coal. The third was a top blast which was installed because it was used in all malleable iron foundries.

successful operation by the Combustion Economy Corporation, with pulverized coal as fuel in one of the largest malleable iron foundries in the United States. This furnace was of 10-ton capacity and was formerly fired by hand. Only a few slight changes were necessary in the firebox, such as filling the ash pit, lowering the front bridge wall, removing the top blast and altering the firebox front to provide for the burner pipe.

The general dimensions of the furnace are as follows: Length between bridge wall 15 ft. 6 in., width at tap holes 5 ft. 6 in., firebox 40 x 59 in.; diameter of stack 29 in., height of walls at tap holes 31 in., depth of metal at tap holes 9 in. This is considered a very small furnace. On larger furnaces the results should be even more favorable.

The method of introducing the burner into the furnace is illustrated in Fig. 3.

A comparison of the operation of this furnace with hand-firing and with powdered coal is as follows:



FIG. 3. VIEW OF A 15-TON AIR-MELTING FURNACE FOR MALLEABLE IRON WITH PULVERIZED COAL BURNER

The company's engineer, however, considered this custom to be the result of superstition rather than necessity and the top blast was finally discarded. These sweeping changes have added greatly to the efficiency and simplicity of operation of the furnace.

Two heats are run off per day. The first is started with a cold furnace and tapped off in about 4.5 hours after lighting the burner. The second heat is started with a hot furnace and is poured in about 3.5 hours after starting the burner the second time.

The advantages derived in melting malleable iron with pulverized coal, as compared with hand-firing, are:

(1) Increased economy. The ratio of coal to iron in hand firing, under the best conditions, was not over 1 to 2.5, while with pulverized coal the ratio is 1 to 4.5.

(2) Owing to complete control of the melting conditions and of the speed of the operation, the heats may be tapped at exactly the time set in advance. This does not vary from day to day more than 5 minutes.

(3) A hotter and more fluid iron is obtained which is very desirable in malleable iron practice. This cuts down the losses from misrun castings.

(4) The cost of repairs to the furnace has been reduced approximately 50 per cent.

(5) The labor saving, in running the furnace, is about 1½ men.

In 1919, a malleable melting air furnace was put in

¹The writer is indebted to H. E. Bailey of the Erie Works of the General Electric Co. for information.

	Hand-Fired Coal	Powdered Coal
Air pressure at furnace, oz.....	2 to 3	½ to 1
Diameter main blast pipe, in.....	18	15
Volume of main blast, cu.ft. per min.....	3,500	3,500
Time of melt, hours:		
Hot furnace.....	5.5	3.5-4
Cold furnace.....	6.5-7	4.5-5
Coal per ton of iron melted, lb.....	940	600

PERCENTAGE OF SAVING

Coal.....	31
Pig iron replaced by scrap.....	18
Time of melt.....	30
Labor.....	60
Skimming bars.....	30
Cost of repairs.....	29

In comparing the pulverized coal-fired furnace with the hand-fired furnace there are a number of other outstanding advantages which cannot be expressed in figures.

These have been summed up as follows:

- Less slag to dispose of, including all melted ash.
- Practically no ashes to dispose of.
- No cleaning clinkers from firebox.
- No grate bars. No top blast.
- No smoke at any time.
- More uniform analysis of castings.
- Cleaner furnace surroundings.
- Easier on workmen, making them more satisfied, as there is less poking, leveling and skimming.
- Decreased oxidation of metal.

It is suggested that in malleable iron foundries where it has not paid to pulverize the fuel required for annealing alone it should now be possible to use pulverized fuel on a sufficient scale to prepare it economically.

Schenectady, N. Y.

Enameled Products Research Laboratory

Layout of Departments, With Enumeration of Laboratory Equipment—Organization Involving Services of Ceramic, Chemical and Metallurgical Engineers in Manufacture and Development of Uses for Enameled Apparatus—Method of Control and Research Applied to Orders and Inquiries

By EMERSON P. POSTE

Director of Laboratories, Elyria Enameled Products Co., Elyria, Ohio

THE keen interest which has recently been taken in the relation of the research laboratory to industry, together with complimentary remarks which have been made by persons who have visited the Elyria Enameled Products Laboratory, have suggested that it might be worth while to present the manner in which the manufacture of enamel-lined equipment depends upon the research laboratory for meeting the demands of the trade.

The field served by enamel-lined equipment is very large, including all phases of the dairy industry, the

The department of ceramic engineering has supervision over the preparation as well as the processing of the enamel in the factory. Its particular duty is to see that a given piece of apparatus leaves the factory properly enameled. This involves the improvement of existing commercial formulas and the development of new ones.

The chemical engineering department functions in co-operation with the sales department in specifying the proper equipment to meet the conditions of a given inquiry and also in developing new uses of enamel-lined equipment.

The metallurgical department has to do with metallurgical problems in the factory, which include foundry control, selection of proper steel for the construction of equipment and the effect of the enameling operation on the metal in the apparatus.

EQUIPMENT

With these general features in mind, it will be of interest to consider in detail the laboratory and its equipment. Fig. 1 shows a floor plan of the building. In the front portion of the building are the laboratory offices and library, which includes a well chosen set of references bearing on the problems of interest to the organization.

The analytical laboratory, a corner of which is shown in Fig. 2, occupies the remainder of the front wing. This laboratory is thoroughly equipped for the analysis of iron and steel, enamel raw materials, enamels and the various substances which may be submitted by the chemical engineering department in connection with its work.

The engineering laboratories are found in the main portion of the building, ceramic engineering to the east

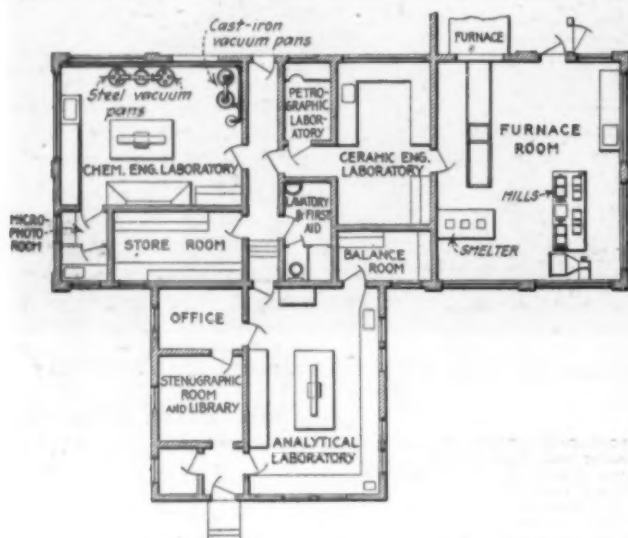


FIG. 1. FLOOR PLAN OF CHEMICAL LABORATORY

processing of edible fats and oils, the preparation of canned foods and beverages and the manufacture of various pharmaceutical and chemical products.

If the equipment supplied to the trade is to prove satisfactory, two fundamental requirements must be realized; the apparatus must be of such a quality from a mechanical point of view that it will stand up under the service to be met and it must be so designed as successfully to carry out the operations for which it is intended.

The laboratory plays a very important part in the realization of these fundamental requirements both as to the manufacturing of the equipment and the proper design to meet the specific purposes. Besides these routine matters, there are many research problems which constantly call for attention bearing on actual factory processes as well as the use of equipment.

The laboratory organization necessary to meet the above functions includes the following departments: Ceramic engineering, chemical engineering and metallurgical engineering. In addition to these, the analytical department serves the three other departments as occasion may demand.



FIG. 2. A CORNER OF THE ANALYTICAL LABORATORY

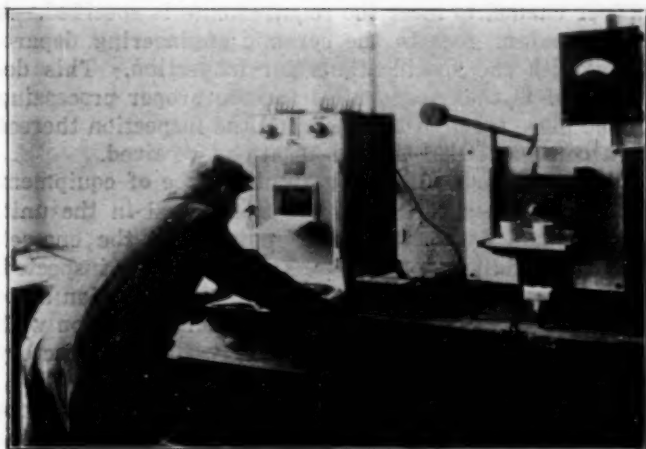


FIG. 3. A CORNER OF THE ENGINEERING LABORATORY

and chemical engineering to the west of the hall. The ceramic laboratories include a general laboratory in which are found various electric furnaces, drying ovens and miscellaneous equipment for the control and study of enameling operations, and a mixing table for the preparation of experimental enamel batches. A corner of this room is shown in Fig. 3. Adjacent to the general ceramic laboratory is a petrographic laboratory, equipped with the latest model of petrographic microscope and refractometer for the study of the optical properties of enamel raw materials and enamels. A corner of this room can be seen in the background of Fig. 4.

The furnace room, adjacent to the general ceramic laboratory, contains a complete experimental enameling plant. Experimental batches which have been mixed in the ceramic laboratory are smelted in the crucible furnace shown in Fig. 5. The frit obtained from this furnace is ground in Abbe and Patterson jar mills and the resulting enamel is sprayed onto the experimental ware by the use of a Paasche spraying equipment. The grinding and spraying apparatus are shown in Fig. 6.

The burning equipment consists of a 3-ft. muffle furnace, the front of which, together with the charging machine, is shown in Fig. 7. This department also includes various miscellaneous pieces of equipment, such as crushers and Rotap sieve shaker.

The laboratory pyrometric equipment consists of a Leeds & Northrup potentiometer, Leeds & Northrup

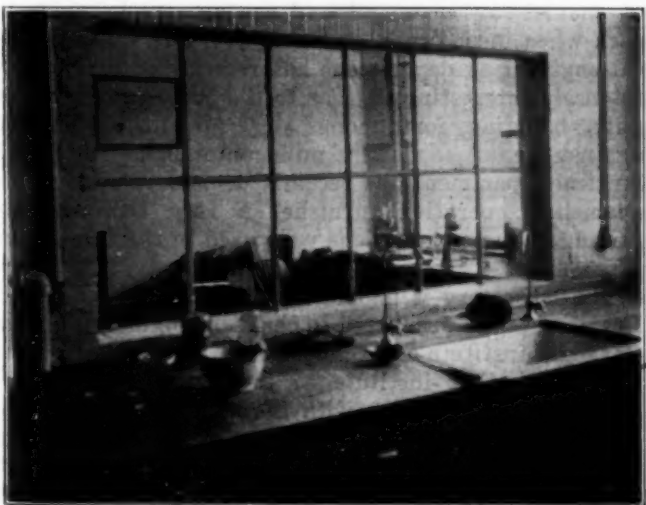


FIG. 4. A CORNER OF THE PETROGRAPHIC LABORATORY

optical pyrometer, Thwing radiation pyrometer and Brown portable pyrometer. This equipment is used for checking factory pyrometric equipment as well as in connection with experimental work.

The equipment of the ceramic engineering department makes possible the experimental processing of any type of enamel which may be of interest, together with a thorough study of the physical and chemical properties of enamel raw materials and enamels.

The chemical engineering laboratories are equipped with the necessary apparatus for studying field problems from the initial to the semi-commercial stage. The equipment includes the usual glass and porcelain units and a variety of semi-commercial models of agitation, emulsification and similar apparatus.

In addition to various small enameled units, there are available in the laboratory a 2-gal. jacketed enameled unit, an open-top 5-gal. enamel-lined kettle and two sets of semi-commercial vacuum pans.

Fig. 8 shows the steel vacuum pans so assembled as to make possible the processing of various materials under different methods of heating. The pan at the

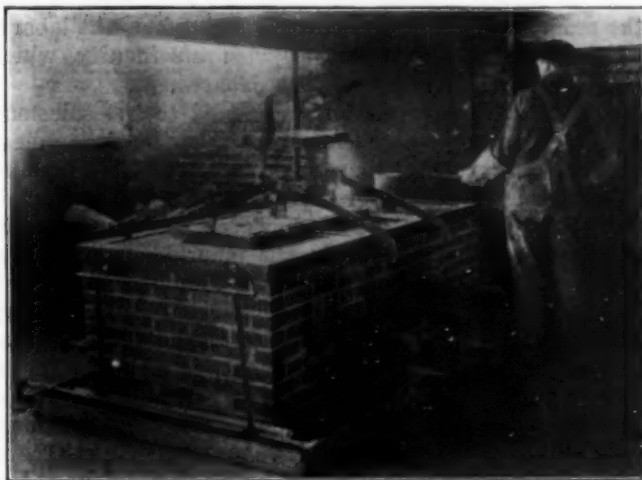


FIG. 5. EXPERIMENTAL CRUCIBLE FURNACE

left is equipped with silver-plated copper coils as a heating medium and the one at the right with a steam jacket. The condenser and receiver are shown in the center. Either pan can be attached to the condenser and various types of agitating devices can be used as indicated on the pan at the right.

Fig. 9 shows the cast-iron jacketed vacuum pan with condenser and receiver. This particular unit is used in connection with problems involving mineral acids necessitating the use of the more acid-resisting cast-iron enamel. The vacuum requirements of the entire laboratory are served by a Crescent rotary vacuum pump with a capacity of 50 cu.ft. of free air per minute.

The chemical engineering department also has available for the testing of actual commercial units a portion of the testing floor of the factory and carries on such tests on full-sized units as may be desirable.

The metallurgical equipment includes such apparatus as is necessary for physical tests on the various materials of construction and metallographic studies in connection with the enameling operations. The work of this particular nature is done in the microphotography room opening off the chemical engineering laboratory.

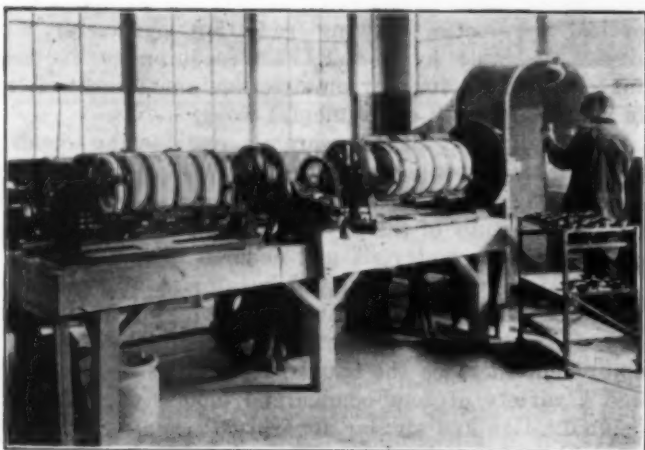


FIG. 6. GRINDING AND SPRAYING APPARATUS

The laboratory building also contains a store room and comfort room in which first aid work is given to factory employees.

THE LABORATORY AND THE FIELD

With this equipment in mind, we may assume that the reader will be interested in knowing how the laboratory functions in connection with an inquiry which may be received from the sales department.

The original information submitted to the salesman is turned over to the chemical engineering department for consideration. If there is on file a sufficient amount of information to cover the case, definite action is taken. It may be necessary, however, to carry on additional experimental work in the laboratory or to send a laboratory representative to the customer to make a more detailed study of his problem. If the laboratory comes to a definite conclusion as to the feasibility of furnishing the proposed equipment, it makes a report specifying the exact equipment which should be furnished for the case in hand, the engineering department co-operating in working out the actual design. If, on the other hand, the laboratory, through previous information or by further experiment, finds that enameled equipment would not satisfactorily serve the purpose in mind, a report to this effect is submitted to the sales department.

When the order is reached by the manufacturing department, it first goes to the laboratory, is correlated with previous experimental work on record, and the

proper enamel to meet the requirements is specified. A memorandum goes to the ceramic engineering department with the specifications for inspection. This department is then responsible for the proper processing of the piece through the shop and the inspection thereof in accordance with the specifications received.

Records bearing on every specific piece of equipment include the composition of the metal used in the unit, the formula and actual batch number of the enamel, and the condition of the tank when finally inspected, as well as a full record of the specific information as to the intended use. Field observations in connection with the particular unit are correlated with these factory records later.

It will be of further interest to consider briefly some typical research problems which are at present on the laboratory schedule. The ceramic engineering depart-

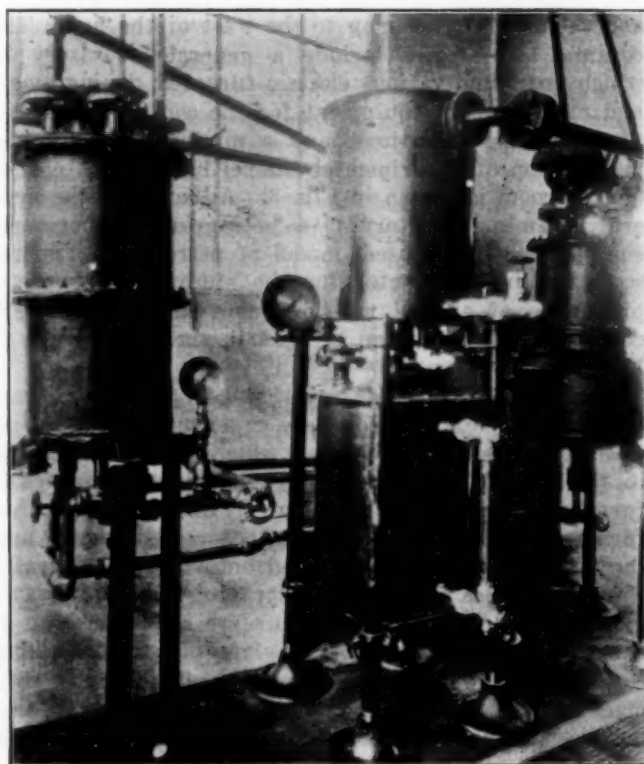


FIG. 8. STEEL VACUUM PANS

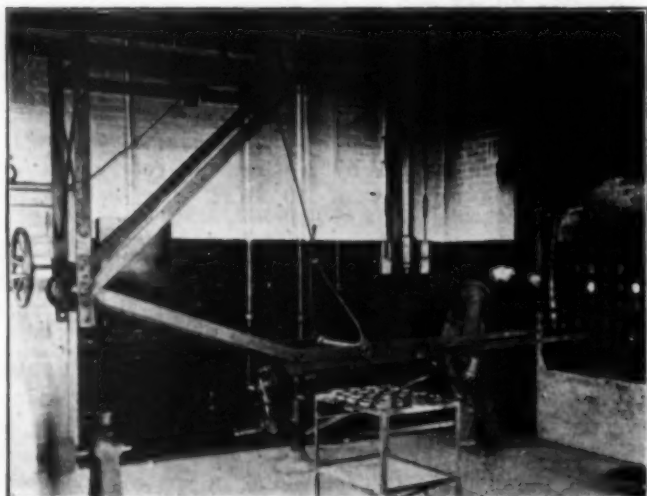


FIG. 7. MUFFLE FURNACE AND CHARGING MACHINE

ment is making a very thorough study of the properties of enamel raw materials and the general behavior of each when incorporated in an enamel mix. The chemical engineering department has recently obtained some intensely interesting data as to the action of metals on milk, bringing forth some very striking arguments against the use of metallic milk containers. The metallurgical department has recently demonstrated that the enameling operation furnishes a very thorough annealing of the oxyacetylene weld used in the fabrication of steel units.

The laboratory is under the direction of Emerson P. Poste, who was graduated in chemical engineering from Carnegie Institute of Technology in 1910 and after two years with that institute as instructor in chemistry assumed his connection with the laboratory.

Bryan A. Rice, who is in charge of the ceramic engineering department, was graduated from the department of ceramic engineering of Ohio State University in 1917. After two years of commercial experience

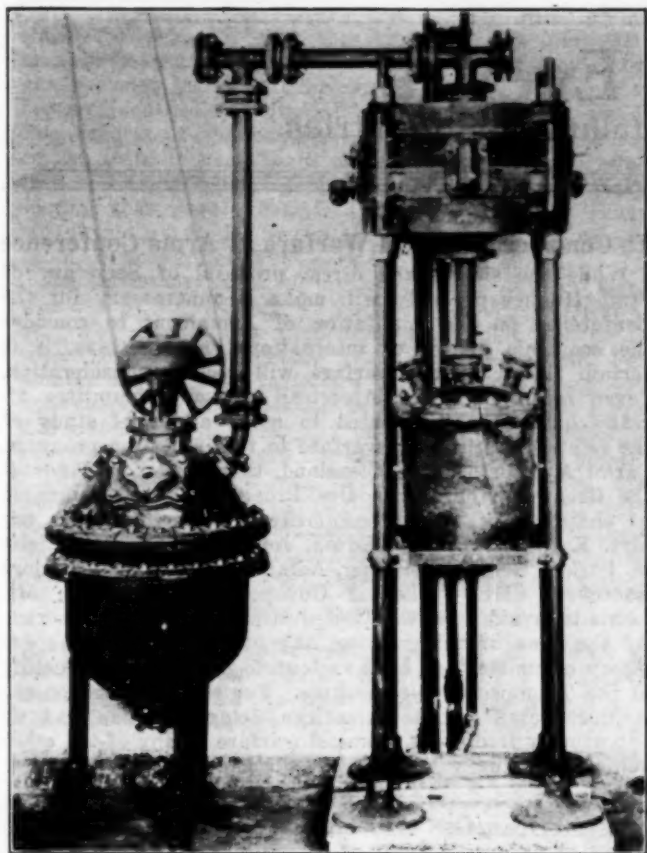


FIG. 3. CAST-IRON JACKETED VACUUM PAN WITH CONDENSER AND RECEIVER

with the company, he returned for post-graduate work in connection with certain problems of enamel technology.

The chemical engineering department is in charge of Max Donauer, who after his graduation from the department of chemical engineering of the University of Minnesota has had a considerable commercial experience along his line, including very responsible duties in charge of the Ordnance Control Laboratory of Philadelphia during the war. He has held his present position for the past two years.

In addition to the above heads of departments the laboratory staff includes several assistants who perform the analytical and other routine work.

Zinc Cyanide Plating Solutions

Zinc coatings furnish by far the best protection against corrosion of steel, and for this reason zinc plating or electrogalvanizing was extensively applied to all sorts of machinery during the war. Satisfactory zinc deposits can be secured from either sulphate or cyanide solutions, but the latter possess the advantage of "throwing" the deposit better into deep depressions or upon the surface of irregularly shaped articles. The cyanide solutions were, therefore, given first consideration in the investigations conducted by the Bureau of Standards. It is hoped later to extend this study to include the sulphate solutions. It was found that satisfactory zinc cyanide plating solutions can be made by using zinc oxide to replace part or all of the zinc cyanide formerly employed for this purpose.

Technologic Paper 195 of the Bureau of Standards describes the above work and gives formulas for satisfactory solutions and general directions for their use.

Book Reviews

CONCENTRATION BY FLOTATION. By T. A. Rickard. New York: John Wiley & Sons, Inc. 692 pp. Illus. Price \$7.

Just at the time that T. A. Rickard returned to San Francisco from London to assume the management and editorship of *Mining and Scientific Press*, flotation was assuming a position of importance in the United States. Mr. Rickard immediately perceived that here was just such an opportunity as, if taken hold of, would give his paper such renewed impetus as it appeared to him just then was so essential.

With this end no doubt largely in view, but also on account of his own keen personal interest in all subjects of vital importance to the profession, he made "flotation" the slogan of his journal and thus attracted to it, in advance of others, a series of interesting articles upon this new subject; his paper having become, for the time, the repository of its newly making literature. It was therefore most natural that such a series of articles as appeared in the *Press* should find more ready means of access in book form.

Two volumes comprising reproductions of these articles which had appeared in *Mining and Scientific Press* have been published previously. This third volume, however, is presented as more complete, and contains, besides twenty-two articles which were in the previous volumes, eighteen later articles. As the preface to this third states, it does not profess to be complete or final. The subject matter is somewhat confusing in its sequence of articles, as what is practically the same topic appears in widely separated chapters, by different writers and without apparent arrangement.

It would take one far beyond the limits of such a book review as this to attempt any comparison of one of these chapters with another, or to note differences and similarities of opinions given, or to discuss what the reviewer feels to be regrettable misconception as to some important matters. However this may be, it is a convenient collection of much that is most interesting, and references cited add greatly to its scope.

R. C. CANBY.

AMERICAN CHEMISTRY. By Harrison Hale. 215 pp., 63 illustrations. New York: D. Van Nostrand Co. Price, \$2.

Dr. Hale has chosen to review American chemistry in such a way as to interest both the layman and the student in the achievements of our chemical industry and its inviting possibilities for future developments. Considered from this point of view, his book must be regarded as a very creditable attempt to serve an excellent and worthwhile purpose. That it falls short of its goal in a number of outstanding instances is to be regretted, especially so when it is realized that some of its faults are inexcusable. In the first place there is abundant evidence of careless writing, loose construction and generally inefficient use of English. It is apparent, too, that the author has not been altogether successful in adopting the non-technical style, which is so essential if he is to attract and hold the interest of the general reader. There are many technical expressions and unfamiliar words which might well have been avoided or at least given some explanation for the benefit of the layman. If, however, we consider the second purpose of the book—namely, "for use either as collateral reading along with a course in general chemistry or as a short separate study"—some of reviewer's criticisms do not apply. Certainly, it is a laudable desire to acquaint the student with the industrial importance of the science he is studying. His interest in his immediate task is stimulated, his viewpoint is broadened, and, if he is a red-blooded American, his patriotism is stirred by the record accomplishments of American chemistry. The author has done much to encourage the student's interest in current literature and the technical press, and the frequent reference to these sources of information will undoubtedly prove very useful. Furthermore, the many well-chosen illustrations add materially to the value of the book.

S. D. KIRKPATRICK.

Current Events

in the Chemical and Metallurgical Industries

More Plants Resume Operations

Leather. The New Castle Leather Co., Wilmington, Del., has added about 100 men to its working force, increasing production to approximately 90 per cent of normal.

Rubber. The Firestone Tire & Rubber Co., Akron, Ohio, is increasing its working force with intention of developing production to a point of about 18,000 tires a day.

Acid. The Marion Extract Co., Chattanooga, Tenn., manufacturer of tanning extracts, resumed operations at its plant on Nov. 7, following a curtailment for some time.

Coke. The Domestic Coke Corp., Fairmont, W. Va., has resumed production on a basis of about 40 per cent of normal, following curtailment for a considerable time.

Ceramic. About 250 kiln drawers employed at East Liverpool, Ohio, potteries who recently declared a strike against a wage reduction of 7 per cent, have returned to work pending a settlement with employers.

Iron. The Ulster Iron Works has reopened its plant at Dover, N. J., following a shut-down dating from last spring. Substantial wage reductions have been placed in force. Puddlers heretofore receiving \$9 for a 10-hour day, will be paid \$5.50; and helpers \$4.01, as compared with \$6 when the plant closed.

The Reading Iron Co., Reading, Pa., has resumed production at its puddle furnaces at the Ninth St. mill, and seventeen units have been placed in service. The larger portion of the plant has been idle for a number of months.

The Carnegie Steel Co., Youngstown, Ohio, has blown in another blast furnace at its local mills, making four out of seven units now in service.

The United States Cast Iron Pipe & Foundry Co., Chattanooga, Tenn., has resumed operations at its local plant, following a shut-down since last January.

The Republic Iron & Steel Co., East Chicago, Ind., has opened its local plant, following a period of inactivity for about three months past. About 200 men will be employed at present, and which number will be increased gradually as conditions warrant.

Steel. The United States Steel Corporation, New York, N. Y., is now operating at about 51 per cent capacity at its various mills, the highest production record since last March. At one time in July a low point of 18 per cent of normal was reached.

The Bethlehem Steel Co., Bethlehem, Pa., has resumed operations at its 20-in. rolling mill at the Steelton, Pa., works, following a shut-down for several weeks through lack of orders.

The Carnegie Steel Co., Pittsburgh, Pa., is giving employment to about 5,600 men at its various plants at the present time, as compared with a normal working force of 6,800 men.

Metal. The International Silver Co., Meriden, Conn., has adopted an overtime operating schedule at its Factory L, Wallingford, Conn. With a 55-hour week in force, about 250 operatives will work four nights a week until 9 o'clock. A number of new workers are being employed.

Tinplate. The American Sheet & Tinplate Co. has resumed full operations at its Elwood, Ind., plant, placing twenty mills in service Nov. 7, with employment of about 1,500 men.

Laboratory Car for Brick Kiln Tests

Arrangements have been made in connection with the co-operative agreement between the associations of brick manufacturers and the Bureau of Mines to fit up a laboratory car which will be used in testing kilns at brick works. This will make possible a much more expeditious handling of this very necessary phase of the work and will permit its being done in a very thorough manner.

To Consider Chemical Warfare at Arms Conference

While the simple and direct proposal of Secretary of State Hughes probably will make it unnecessary for the Conference on the Limitation of Armament to consider the economic phases of international relationships, it is certain that chemical warfare will receive consideration. Seven members of the American advisory committee already have been designated to make a special study of the relation of chemical warfare to the limitation program. Carmi A. Thompson, of Cleveland, the general manager of the Great Northern Iron Ore Properties, was designated as chairman of the sub-committee. Other members are Mrs. Katherine Phillips Edson, John L. Lewis, Gov. John M. Parker, General Pershing, Admiral Rogers and Theodore Roosevelt. Mr. Parker is Governor of Louisiana; Mr. Lewis is president of the United Mine Workers of America. At the time of this writing, the other duties of the advisory committee had been such as to preclude any meeting of the Thompson sub-committee. For the same reason the technical staff of the American delegation has had no opportunity to discuss chemical warfare or any of the other subjects coming within its jurisdiction.

American Gas Association Meets in Chicago

The third annual convention of the American Gas Association met in Chicago during the week ended Nov. 12. General sessions were held each morning at the Congress Hotel, while the five sectional meetings were held during the afternoons in rooms at the Congress and Auditorium hotels. These sections are the accounting, commercial, publicity and advertising, the technical, and the manufacturers' section. At the same time exhibits of gas appliances and gas-plant apparatus were shown by the manufacturers in both the Elizabethan Room and the Florentine Hall of the Congress Hotel. Entertainment features of the convention included the president's reception, the annual banquet followed by a dance, arrangements for golf fans, and a trip to the new plant of the Chicago Byproduct Coke Co.

GENERAL SESSION

President Charles A. Monroe opened the general session with an address on the progress of the association. It was organized in June, 1918, in New York City to promote and develop the gas industry and effect the best service to the public. The year 1920 was the darkest for the industry and the strain has humbled every man in the business. This has been a great thing, because it has driven the members to seek co-operation. The gas industry was one of the first to feel the effects of tax exemption on government and state securities. The association has made progress in arousing public sentiment against tax on public utility securities. In co-operation with the National Electric Light Association and the American Electric Railway Association a committee has been organized to support the Smoot bill.

There is a general need as regards specifications for a general lowering of the calorific standard for national conservation of our fuel. Conservation of life in the industry through new resuscitation methods has been effected, and particularly good work has been done by the committee operating under the direction of Dr. Cecil Drinker, of Harvard University.

Increased cost of producing gas has called for increased rates if the utilities are to survive. The public understands the gas industry situation better than ever before. The association must continue to point out to the universities the need of technical men trained in the gas industry. The University of Michigan now has a 3-year course in

gas engineering. The Natural Gas Association of America should amalgamate with the American Gas Association, because in the course of time as the supply of natural gas becomes less, the problems of both associations will become identical and duplication may thereby be avoided. The reports of the various committees showed the association to be in good shape as regards its business affairs. It now has a surplus of \$92,849. Officers elected for the coming year were: President, D. D. Barnum, of Boston; vice-president, R. D. Brown, of Milwaukee, and treasurer, H. M. Brundage, of New York.

Among other talks of interest at the general session was one by R. P. Perry, vice-president of The Barrett Co., on "Why Should Gas Companies Sell Their Tar to Distillers Instead of Working It Themselves?" Mr. Perry pointed out the wide variations which exist in the physical and chemical properties of tars from different sources, and emphasized the difficulty of producing marketable tar and pitch products from the tar of a single gas plant.

Other speakers of note at the general session were: George B. Courtelyou, national counsel of the Consolidated Gas Co., New York; R. M. Searle, president of the Rochester Gas & Electric Corporation, and Samuel Insull, chairman board of directors, People's Gas Light & Coke Co., Chicago.

TECHNICAL SECTION

At the Wednesday afternoon session, M. E. Benesh presented a paper on "What Goes On in a Water-Gas Machine," in which he described an apparatus for indicating the percentage decomposition of steam during a run. Partially decomposed steam leaving the generator is passed at constant temperature (checked by a dry-bulb thermometer) over a wet-bulb thermometer. Since the dry-bulb temperature is constant, the wet-bulb thermometer may be graduated directly in per cent decomposition of steam.

A. W. Warner, as chairman of the committee on complete gasification of coal, presented a review of several methods of complete and partial gasification. A brief on the gas oil situation was submitted by the committee appointed to consider this subject. Results of tests on refractory materials for use in lining water-gas generators were given by the committee on refractory materials. In spite of the rather negative character of the results obtained to date, the committee stated that it was not pessimistic over the probability of finding more suitable refractories for generator linings than fireclay blocks.

On Thursday afternoon J. T. Griffin discussed a method of removing stoppages of rust in gas lines by the use of cylinders of compressed air at a pressure of 1,500 lb. per square inch. The committee report on the progress made in the research investigations on gas purification problems was supplemented by an excellent selected and annotated bibliography on gas purification. Another phase of purification was treated by W. A. Dunkley in a paper on "The Effect of Moisture on the Activity and Capacity of Iron Oxides for Gas Purification." Practical results in the removal of hydrogen sulphide by the Seaboard liquid process were described at length in a very interesting paper by F. W. Sperr, Jr., which will be treated more fully in a subsequent issue.

"Some Experiments With the Mixing of Different Gravity Gases in Holders" was the title of the first paper presented before the section on Friday. The author, H. E. Bates, called attention to the increasing importance of the problem of the proper mixing of gases, and gave curves showing the results of tests made with a small holder.

One of the most important reports presented at the meeting was that of the carbonization committee. The operators' section submitted standard carbonization data for nineteen plants. The low-temperature carbonization section reviewed the present status of carbonization at low temperature. This report will be considered in more detail in a subsequent issue. Eleven manufacturers of carbonizing apparatus reported in the builders' section, giving interesting data on recent improvements and new designs.

The report of the committee on the disposal of waste from gas plants closed the meeting of the technical section.

Postmaster General Hays Discusses the Tariff

In the course of an address before the Fifth Avenue Association in New York, Nov. 15, Will H. Hays, the Postmaster General, made significant references to the tariff situation. His utterance in some quarters at least is interpreted to mean that there will be no effort to hurry the enactment of the tariff bill. An extract from Mr. Hays' speech follows:

Before 1914 we were a debtor nation—the largest in the world. Today we are precisely the opposite. We are the largest creditor nation in the world. Just what is the effect of the enormous importance of this change in our economic and commercial position in relation to the rest of the world I do not pretend to know. I merely point out that no thorough or open-minded or candid consideration of the tariff question can be complete without including consideration of this new factor. Regardless of what an investigation of this point might reveal—omitting this factor altogether—it is a fact that to thoughtful men there must be approval of a certain hesitation and disposition to be cautious and a determination to be sure-footed in the consideration of the whole subject of the tariff. Conditions throughout the world are so chaotic that it's difficult to foretell exactly what is needed. The very basic condition on which a tariff is built—the cost of manufacturing in various European countries with relation to our own cost of manufacture and the value of the currency of the various European countries with relation to the value of our own currency—is at the present moment as fluctuating as quicksand. To build a dependable tariff on such a foundation is difficult, of course. It has been thought by many that we could overcome these handicaps by a device which is called American valuation and which provided that all customs duties shall be estimated upon the value of goods at the time when they arrive in the United States and in terms of American money. The Congress in a proper eagerness for information has made an appropriation of \$100,000 to investigate the device and otherwise determine what might be done to help us toward writing a permanent tariff. This was proper, but a much better arrangement and one which is very definitely in the mind of the administration for accomplishment, is to make the Tariff Commission a really useful and functioning institution which will constantly study the situation and with sufficient authority, which ought to be given it, be able to meet any and all conditions which obtain or emergencies which may arise. The work of the special investigation has been going on and with the adjustment of our international relations by the accomplishment of the steps which the President has in mind we may expect relief from some of the conditions of fluctuation and instability so that proper permanent tariff making is possible.

Washington Section Officers Selected

R. C. Wells, of the U. S. Geological Survey, will be president of the Chemical Society of Washington for the coming calendar year, as a result of the election of this section of the American Chemical Society, held on Nov. 10. Other officers selected were: J. B. Reed, secretary; H. W. Houghton, treasurer; W. D. Collins, R. B. Sossman, W. W. Skinner, W. M. Clark and William Blum, councilors; and C. W. Bacon, V. K. Chestnut, L. H. Adams, F. C. Cook, C. O. Appleman and R. O. E. Davis, members of executive committee. The past presidents of the section addressed the meeting during the course of the election on various interesting developments in their several fields and regarding some interesting events in the earlier history of the society and the Washington section.

New Gas-Fired Kiln to Be Demonstrated

Arrangements are being made for a number of demonstrations in this country of a new gas-fired kiln for ceramic products, and primarily pottery, invented by Arthur G. Shaw of the Shaw Glazed Brick Co., Ltd., Glasgow, Scotland. Mr. Shaw, who recently arrived in the United States, states that the new kiln shows a saving of from 66 to 85 per cent in fuel and about 30 per cent in labor. P. Wylie Rodger of the Gartgraig Fire Clay Co. and Walter Bakewell of the Cauldon Potteries are accompanying Mr. Shaw.

International Labor Conference Discusses White Lead and Anthrax Poisoning

Much discussion has resulted from the consideration of the question of prohibiting the use of white lead in painting, by the International Labor Conference, now in session in Geneva, at which thirty-nine governments and the workers' and employers' organizations of those countries are represented.

Early in the conference the question was referred to a commission which was to study the subject and prepare a report to the conference. According to cabled information received at the Washington office of the International Labor Office, this commission has now returned a majority report opposing the prohibition of the use of white lead in painting, and stating that it is the opinion of the commission that the prohibition is not necessary in the interests of the painters, nor desirable in the interests of the users or producers of white lead. The commission recommended a draft convention for the regulation of the use of white lead in painting, such as measures for avoiding danger from dust in dry scraping, dangers of spraying with white lead pigments, provision of adequate washing facilities for those using white lead pigments, etc.

A minority report was also presented by members of the commission, which calls for the complete prohibition, or at least for the prohibition in interior work, of the use of white lead in painting.

The question of the disinfection of wool infected with anthrax spores, which appears on the agenda of the conference, has been disposed of by the unanimous adoption of a resolution to refer this question to a special committee to be appointed by the governing body of the international labor organization. It was suggested in the resolution that the British Government be asked to nominate the chairman of this committee. The resolution further stated that "the International Labor Conference is of the opinion that the co-operation of the United States of America should be invited on this question."

Chemical Salesmen Meet in New York

The Salesmen's Association of the American Chemical Industry held a dinner meeting in New York on the evening of Nov. 15, at which a number of important matters of business were transacted. It was announced that the plan to organize local chapters was proceeding satisfactorily. It seemed wise and opportune for the New York members to organize as a chapter and accordingly this was done by electing the following officers: Ralph Dorland, of the Dow Chemical Co., chairman; George H. Short of Wilckes, Martin & Wilckes, secretary, and Spencer Levy, editor of the *American Perfumer*, treasurer.

Charles B. Hall, of the Cleveland-Cliffs Iron Co., chairman of the Cleveland local chapter, made a brief address expressing the spirit of good will and co-operation that the Cleveland members hold toward all other members of the association. Theodore R. L. Loud, of the New York Quinine & Chemical Works, Inc., gave a brief but inspiring review of some of the early characters and traditions of the medical chemical industry in this country. He mentioned specifically such men as Weightman, Rosengarten and Squibb. This was followed by an address by Saunders Norvell, of McKesson & Robbins, in which he gave the members of the association very helpful business advice.

New Chemical Companies Organized

During the month of October twenty-six new companies in the chemical, drug and affiliated fields were organized with a capitalization of \$50,000 or greater, as compared with the formation of thirty-five such companies in September. The October aggregate shows a combined capitalization of \$6,675,000, as against the September total of \$7,450,000. During the month of October a year ago the aggregate capitalization of new companies was \$4,825,000.

The first 10 months of the present year shows a combined authorized capitalization of \$98,515,000 for new chemical companies; in the corresponding period for 1920 the aggregate reached \$180,467,000.

Excess Varieties of Paving Brick Eliminated

An indication of what may be accomplished in the elimination of waste and of excess variety was had when manufacturers and consumers of paving bricks perfected an arrangement in a 2-hour conference whereby fifty-five varieties of paving brick were eliminated from the sixty-six styles now being manufactured. The meeting at which this was accomplished was held in Washington Nov. 15 under the auspices of the Department of Commerce. While shrinkage of clay and other ceramic phases of brick-making came in for some discussion in the matter of variations from the dimensions fixed as standards, these technical questions are to be handled by special committees now working in co-operation with the Bureau of Standards. Similar conferences are planned to consider other types of brick.

The work begun at the Washington conference is to be carried on by a committee to be composed of representatives of the following organizations: National Paving Brick Manufacturers Association, Chamber of Commerce of the United States, American Society of Civil Engineers, American Association of State Highway Officials, American Society of Municipal Improvement, American Society for Testing Materials, Federated American Engineering Societies, Bureau of Public Roads, Bureau of Standards.

Alloy Work Discussed

The work on alloys being done by the Bureau of Mines was reviewed at a meeting between bureau officials and the standing committee of the American Institute of Metals. It was decided that the standing committee would meet twice a year in the future at the Bureau of Mines. Those in attendance at the meeting were H. Foster Bain, director, Bureau of Mines; W. M. Corse, Monel Metal Products Corp.; R. B. Moore, chief chemist, Bureau of Mines; William B. Price, Scovill Manufacturing Co.; W. H. Bassett, American Brass Co.; R. J. Anderson, Bureau of Mines; L. W. Olson, Ohio Brass Co.; C. H. Bierbaum, Lumen Bearing Co.; George C. Stone, New Jersey Zinc Co.; W. R. Webster, Bridgeport Brass Co.; H. W. Gillett, Bureau of Mines; DeCourcy Browne; Paul D. Merica, International Nickel Co.; J. L. Jones, Westinghouse Electric & Manufacturing Co.; John F. Thompson, International Nickel Co.; William A. Cowan, National Lead Co.; Andrew Stewart, Bureau of Mines; Dorsey A. Lyon, Bureau of Mines; E. L. Mack, Bureau of Mines.

Directors' Meeting American Electrochemical Society

At a meeting of the directors of the American Electrochemical Society held in New York on Nov. 16, Dr. Colin G. Fink was elected secretary to fill the unexpired term of Dr. Joseph W. Richards, deceased. The directors received an exhaustive report of the finance committee and considered various ways and means for putting the society on a sound financial basis. From its inception the society has maintained dues at \$5, but it may be necessary to increase this sum in order to get more revenue. Temporarily an increase in revenue will be obtained by charging \$3 per annum instead of \$5 per annum for the bound volumes of the society's *Proceedings*, but a constitutional amendment will be initiated to increase the dues from \$5 to \$8. If this is accomplished, the price of bound volumes will be restored to \$5. The treasurer of the society was authorized to use his discretion in disposing of assets in the form of bonds to meet current expenses.

Further Hearings to Be Held on Water Pollution Bills

Recognizing that it has before it a very knotty problem and one likely to cause hardship to manufacturing enterprises, the Rivers and Harbors Committee of the House of Representatives has determined to hold further hearings on the various bills proposing remedies for the pollution of coastal waters and the waters of streams. The hearings are to be reopened on Dec. 7.

American Electrochemical Society Honors the Memory of Dr. Joseph W. Richards

The meeting of the New York Section of the American Electrochemical Society held at Rumford Hall Nov. 16, 1921, was devoted to addresses and reminiscences on the life and work of the late Dr. Joseph W. Richards, who had been the society's first president.

Dr. Charles Doremus, acting as chairman, introduced Acheson Smith, the president of the society, who related some of the outstanding incidents in the work of Prof. Richards as president and secretary of the American Electrochemical Society and expressed the gratitude due his memory for his ever active interest in the welfare and usefulness of the society.

DR. RICHARDS AS EDITOR AND AUTHOR

The work of Dr. Richards as an editor and author was outlined by H. C. Parmelee, editor of *CHEMICAL & METALLURGICAL ENGINEERING*. He commented on Dr. Richards' part in founding the monthly magazine, *Electrochemical Industry*, in 1902, and his activities as president of the Electrochemical Publishing Co. of Philadelphia, which published this magazine until the end of 1912, when it was purchased by the McGraw Publishing Co. During this period and even up to within a few days of his death, Dr. Richards made many valuable contributions to this magazine, which has since become *CHEMICAL & METALLURGICAL ENGINEERING*. In the field of authorship Dr. Richards contributed abundantly to the technical literature, the most widely known works being his book on Aluminum and the revised *Metallurgical Calculations*. Mr. Parmelee then related some intimate reminiscences of his early connection with Dr. Richards in editorial matters and referred to him as an indefatigable worker and an inspiration and example to all.

DR. RICHARDS AS PRESIDENT AND SECRETARY OF THE SOCIETY

Dr. Carl Hering, one of the founders of the society, gave a historical review of the conferences in Philadelphia among a handful of men enthusiastically interested in the growth of the electrochemical industry, which led to the foundation of the monthly *Electrochemical Industry* with Dr. Richards as president and Dr. E. F. Roeber as editor. He then outlined the history of the foundation of the Electrochemical Society with Dr. Richards as the first president. He spoke highly of the services rendered to the society by Dr. Richards, who, it is worth recording, was the only member twice honored with the presidency of the society, and his tireless work as secretary from 1907 to the time of his death.

Dr. Hering then conveyed the messages he had received from Dr. C. J. Reed, another member of the still living handful of founders of the society, and from C. O. Mailloux, the president of the American Institute of Electrical Engineers.

In the telegram, dated Nov. 13, from San Francisco, Dr. Reed said: "Distance prevents my attending the Joseph W. Richards memorial service. I desire to express through you my feeling of what must be the universal feeling that in the death of Dr. Richards the American Electrochemical Society has suffered the irreparable loss of one whose original interest and subsequent self-sacrificing devotion made possible the organization and perpetuation of the society."

Dr. Mailloux' message, dated Nov. 12, reads: "At the moment when I am leaving my office to go to the pier to take the steamer for Europe, I receive the announcement of the meeting which is to be held Nov. 16 in memory of the late Dr. J. W. Richards. This letter, which is dictated in haste and which will have to be signed for me by my secretary, has for its object to let you know that I will be with you in spirit and would have liked very much to have been able to be physically present at the meeting. I knew Dr. Richards very well indeed. My acquaintance with him ripened into friendship many years ago when I was a non-resident lecturer at Lehigh University. I had the greatest respect and admiration for him. It may be truly said of

him that he possessed learning, culture and refinement to the highest degree. In certain fields of knowledge which he made his own, he did splendid work which will long keep his memory green in the scientific world. Great as is the loss to the world, the loss to the friends who admired and loved him is much greater; in fact, it is irreparable."

DR. RICHARDS AS TEACHER, MAN AND ARTIST

Dr. W. S. Landis chose to speak on the subject of "Dr. Richards as a Teacher at Lehigh University." He reviewed the latter's life from the time when he came as a lad from England until he became instructor at the Lehigh University, and then gave an account of his great educational service, first as instructor and then for over thirty years as professor of metallurgy at the Lehigh University.

William Richards, the only son of Dr. Richards, spoke of his father in filial and touching appreciation. Dr. Richards' sister told with glowing enthusiasm some of her reminiscences of her brother as the artist and the lover of music and of all that is beautiful and artistically recreative.

Status of Chemists in the Navy

The recent revision of the salary and wage scale in the Navy brought into prominence what is regarded as the very unfortunate status of chemists in the Navy. Chemists as such are scarcely recognized by that department of the Federal Government. The chemists in the Navy service are rated in exactly the same way as are draftsmen, mechanics, blacksmiths and other artisans. They are treated as artisans on the per diem basis.

It is stated by those in close touch with the situation that the Navy has failed to recognize the increased importance of chemistry in warfare. The situation is very different in the War Department, which has a Chemical Warfare Service, in which a large number of chemists are employed, all of whom are given full professional status—exactly the same recognition accorded professional medical men in the Medical Corps.

Unemployment Diminishing and Fewer Inquiries Being Cancelled

Statistics compiled by the Engineering Agency, a technical employment bureau, show that the number of inquiries for technical help in manufacturing, construction, industrial and commercial work steadily decreased from February, 1920, to June, 1921, and since the low month of June has shown an increase. In other words, the average minimum was reached in June and a slow but comparatively steady increase has been in evidence since then. Also, during the declining period many employers were forced to cancel their inquiries due to the falling off of their work, whereas since June there have been very few inquiries cancelled.

Personal

C. H. BRANDES, formerly chief mechanical engineer and general purchasing agent of the American Metal Co., New York, and its domestic and foreign subsidiaries, has severed this connection and announces the opening of offices at 42 Broadway, New York, for the conduct of business on his own account.

NELSON COURTLANDT BROWN has returned to his former position as head of the Department of Forest Utilization, New York State College of Forestry, at Syracuse University.

G. G. CREWAN, who was mechanical engineer with E. I. du Pont de Nemours & Co., Wilmington, Del., is now plant manager for the Refractory Products Corporation, Wilmington, Va.

F. E. DODGE, formerly of The Barrett Co., has recently

been made vice-president and manufacturing manager for the Protexol Corporation, Kenilworth, N. J.

M. L. DOLT, formerly research chemist with the American Cotton Oil Co., Chicago, Ill., is now in charge of food colors and pharmaceuticals at the Calco Chemical Co., Bound Brook, N. J.

GEORGE V. DOWNING, formerly research chemist for I. P. Thomas & Son, Paulsboro, N. J., manufacturers of fertilizers, has become chief chemist for Leas & McVitty, Inc., and the Buena Vista Extract Co., Salem, Va., in the tanning extract departments.

DR. COLIN G. FINK, formerly director of the research laboratory of the Chile Exploration Co., has opened an office as consulting engineer at 101 Park Ave. Dr. Fink was also recently elected secretary of the American Electrochemical Society for the unexpired term of the late Prof. Joseph W. Richards.

KUNO B. HEBERLEIN, formerly president and general manager of the Penoles Mining Co., Mexico, a subsidiary of the American Metal Co., New York, announces that he has severed this connection and opened offices at 42 Broadway for the transaction of business on his own account.

J. W. KIMBALL, formerly research chemist at the Delta Laboratory, Arlington, N. J., has joined the staff of the National Aniline & Chemical Co., Marcus Hook, Pa.

R. B. MOORE, chief chemist of the Bureau of Mines, addressed the New Jersey Chemical Society at Newark on Nov. 14. He discussed the chemical work of the Bureau of Mines and reviewed the work which has been done on helium.

H. C. PARMELEE addressed the Chicago section of the American Chemical Society Nov. 18 on "The Technical Paper and Its New Relation to Industry." Mr. Parmelee also addressed the students of the chemical department of Northwestern University, at Evanston.

R. T. STULL, superintendent of the Bureau of Mines Ceramic Station at Columbus, Ohio, conferred last week in Chattanooga with officials of the Central of Georgia R.R. concerning the co-operative work being done on Georgia kaolins.

LOUIS J. TROSTEL, who for the past two years has been stationed with the U. S. Bureau of Mines at Pittsburgh, Pa., engaged on problems relating to industrial gases and dusts, resigned on Nov. 1 to take a position with the Bureau of Chemistry as assistant chemical engineer. He will be associated with the work of that bureau on the chemical problems relating to explosions from starch and other carbonaceous dusts.

PROF. ARTHUR L. WALKER, professor of metallurgy in the School of Mines of Columbia, was elected a member of the board of Engineering Foundation. Prof. Walker succeeds the late Joseph W. Richards of Lehigh University, who died recently. He will represent the American Institute of Mining and Metallurgical Engineers on the board of the Foundation.

DR. E. R. WEIDLEIN, director of the Mellon Institute, Pittsburgh, spoke before the Philadelphia section of the American Chemical Society Nov. 17 on savings in fuel effected by covering pipes with insulating material.

Obituary

FRANK A. LANE, whose formula made possible quantity manufacture of "mag," a chemical necessary to the perfection of gas masks for American troops in the World War, died in St. Mary's Hospital, Passaic, N. J., Nov. 16, following an operation for an intestinal ailment. His home was 26 Oak Crest Place, Nutley, N. J. Mr. Lane was an expert practical chemist, assistant to the president of the Kalbfleisch Corporation, with offices in New York. After the armistice the Government Bureau of Information declared that no American soldier was killed by gas while using an American mask, according to a statement issued recently by the Kalbfleisch Corporation.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Nov. 21, 1921.

After an interruption of a series of holidays, the chemical market has become settled again and improvement along the entire list was noted. Business is not being booked for large quantities, but the volume of small orders is quite large and this in itself is a very encouraging feature. Leading consumers have shown some inclination toward contracts over next year and are eager to receive shipments on standing contracts. Increased activity has recently been noted at some of the more important chemical plants. Offerings on spot have noticeably diminished, with prices all around well maintained. Present railroad conditions have led leading factors to believe that the remainder of the year will find the chemical market quite active. Price changes during the week have not been of any special importance. Caustic soda and soda ash have remained rather quiet, with ash sales a fraction lower for carload lots. Bichromate of soda retained its former price and found occasional buyers at this level. Bleaching powder continued to move steadily and indications point to a normal market on this commodity for the rest of the year. Cream of tartar is very scarce on the spot market and prices are well sustained around the recent advance. Barium chloride is another chemical that has shown a remarkable comeback, with shipment material practically unobtainable. Yellow prussiate of soda is somewhat easier on spot, but shipment material is still commanding a premium.

CHEMICALS

Bichromate of soda consumers are buying spot goods at 8@8½c. per lb. The demand is chiefly for small quantities and this has kept the general market in a steady position. Imported *chlorate of potash* has been offered in the open market at prices ranging from 5¼@6c. per lb. Domestic producers are still quoting unchanged figures and report a better inquiry from new directions. The call for imported goods has been decidedly better in the past week. Sales of imported *caustic potash*, 88-92 per cent, were reported at 5¼@6c. per lb. on spot. Shipment material was offered at 5½c. per lb. Orders have reached the market in better volume for small quantities, with the bulk of imported shipments going to consumers holding large contracts. *Caustic soda* was offered in various directions at 4c. per lb. f.a.s. New York. There were sales reported down to \$3.90 per 100 lb. for carload quantities and up to \$4.15 for lesser lots. Although prices have eased up somewhat, leading factors stated that the inquiry was fairly active with buyers' views a shade under the general quotations. Producers of *sal soda* offered spot material a trifle lower. A fair inquiry was reported, with prices ranging from \$1.80@\$2 per 100 lb., according to seller and quantity. Spot *prussiate of soda* was offered a fraction lower and interest was not as keen as a few weeks ago. There were sellers offering imported material at 14½@14¾c. per lb. Shipment material was quoted at 14½c. per lb. Conditions in *nitrite of soda* continued somewhat dormant with an occasional sale recorded at 6½c. per lb. The regular quotation heard around the trade ranges from 6½@7c. per lb. There were some large holders that intimated shading on round lot business. Light *soda ash* in single bags moved at \$2@\$2.10 per 100 lb. There were rumors of sales down to \$1.95 for carload quantities. Barrels were sold at \$2.35@\$2.45 per 100 lb., according to quantity and seller. Producers of *acetate of lime* are taking on business at 1¼c. per lb. This is the lowest price recorded on this commodity since the beginning of the year. Prices on *barium chloride* continued to show a stronger tendency and it is very doubtful if much spot material can be purchased. Shipment figures are quoted higher with \$55 per ton heard as the minimum selling price. Spot quotations range from \$58@\$65 per ton. Sellers of *barium nitrate* report sales at 7¼c. per

lb., with a general quotation of 7½@8c., depending on quantity. The market is rather quiet and devoid of any special features. Spot *cream of tartar* is very scarce and doubt is expressed among leading factors of domestic material if better than 28c. per lb. can be done on imported goods. Prices range all the way up to 30c. Imported *sulphide of soda*, fused, was offered at 4½c. per lb. Consumers are showing a moderate interest at the lower figure and sales are reported in better volume. Sellers of *aluminum sulphate* reported a better inquiry, with sales recorded at 2½c. per lb. for the iron free variety. Shipment material was quoted at 2½c. per lb. The commercial variety brought 1½c. per lb.

COAL-TAR PRODUCTS

The coal-tar products market during the past week has been practically without any noticeable features, although prices throughout the list were well maintained. The garment strike has meant a setback to manufacturers of fur dyes and also to several textile mills. Hope is expressed, however, of a speedy settlement and producers seem optimistic about the general outlook. The extension of the emergency tariff has had a stabilizing influence on many consumers who had been doubtful about future protection for the industry and there is a more pronounced tendency to take on forward commitments at right prices. The demand for phenol has eased off a bit, but prices are being held firm. *Benzene* production is increasing as the steel output continues to grow. Refiners are quoting 27@33c. per gal., but are accepting business for future delivery only. Consumers seem more optimistic about their requirements and are now fairly well assured that their contracts will be filled. Resale lots are almost impossible to locate. Although buying on *phenol* has not been as active as a week ago, the general tone of the market is strong and prices are being well maintained at 10c. per lb. and upward for prime white crystals. There were some sales recorded at slightly lower prices for round lots, but 10c. seemed to be the general quotation. A moderate amount of business is being done in *alpha naphthol*, but buyers do not feel inclined to purchase in bulk lots. The crude is held at \$1.10 per lb., and the refined variety is quoted at \$1.25 per lb. Resale stocks of *aniline salt* are light and makers are firm at 24@26c. per lb. with a fair demand reported. Producers of *benzyl chloride* are firm at 20@25c. per lb. for the technical and 25@30c. per lb. for the refined. Demand for *diethyl-aniline* is fairly good and as first hands practically monopolize the market, prices are being held at \$1@1.10 per lb. A fair amount of business is passing in *benzoic acid* at 50@60c. per lb. for the technical and 62@65c. per lb. for the U.S.P. grade. Makers are holding figures at these levels. Producers of *H acid* are asking \$1@1.10 per lb., but sales have been made below these prices. Competition among sellers remain quite keen and has kept some producers out of the market. Competition among sellers of *paranitraniline* is resulting in price shading and sales down to 75c. per lb. were made during the week. Resale stocks have been cleared from the market and makers seem to have things well lined up.

The Chicago Market

CHICAGO, Nov. 18, 1921.

There has been but little change in the general condition of the chemical market in this section during the past two weeks. Practically all factors are enjoying a good volume of business, and with a few exceptions, prices are quite firm. The teamsters' strike delayed deliveries for a couple of days this week, but now everything is moving smoothly. It is noticeable that stocks of quite a few items are getting low and no one seems overstocked on anything.

GENERAL CHEMICALS

Caustic soda is very firm with only a moderate supply available on spot. The ground, 76 per cent, is offered at \$4.75@5 per 100 lb. and the solid at \$4.25@4.50. *Soda ash* is moving in a fair way and supplies are available at \$2.60 per 100 lb. for barrels. *Ammonium chloride* is very firm, with supplies scarce. It is doubtful if 8½c. per lb. on the white granulated could be bettered on material for

immediate delivery. *Barium chloride* is moving in a routine way at \$60@65 per ton for the imported white material. *Carbon tetrachloride* is in good demand, with 11c. per lb. the general quotation. *Carbon bisulphide* is very firm, with supplies light. The lowest offer noted for spot material was 7½c. per lb. in drum lots. *Formaldehyde* is very quiet and is quoted generally at 12c. per lb. for barrels. It is very possible that this price could be slightly shaded with firm business. *Glycerine* prices were advanced this week by refiners to 14½c. per lb. for drums. There was no noticeable large movement of this material. *Iron sulphate* is steady, with a fair demand at \$1.75 per 100 lb. *Epsom salts* are quiet and unchanged as to price. The U.S.P. material is offered by first hands at 2½c. f.o.b. warehouse. *Lead acetate* is quiet, with supplies available at 12½c. for the white granulated.

The bichromates are steady, with only moderate supplies available. The *potassium bichromate* is quoted at 14c. per lb. and the *sodium* at 8½@9c. *Caustic potash* is enjoying a fair demand and is available at 6½c. per lb. for the 88-92 per cent material. *Bicarbonate of soda* continues to move in a fair way at \$2.60 per 100 lb. The demand for *hyposulphite of soda* has fallen off somewhat, but the price is unchanged at \$4.05 per 100 lb. for the pea crystals. *Zinc chloride* is in fair demand and a wide variety of prices is quoted, ranging from 7½c. to 11c. for the granulated in casks.

ACIDS

There were no new developments in the acid markets during the past two weeks, the prevailing tone being firm. *Acetic acid* is in fair demand, the 28 per cent commercial being offered at \$2.50 per 100 lb. in barrels. *Glacial acetic* is not moving so well, although there is a noticeable improvement. Prices are quoted ranging from 9@10½c. per lb., depending on quantity and seller. *Oxalic acid* is moving in a fair way at 16@17c. per lb. The heavy acids are moving in a satisfactory way, according to the producers, and are very firm as to price. *Muriatic acid* is quoted in carboys at 1½c., with the same price for *sulphuric*.

VEGETABLE OILS

There is only a fair movement of linseed oil and supplies are plentiful. The boiled oil in 10-bbl. lots is quoted today at 74c. per gal. and similar quantities of the raw at 72c.

NAVAL STORES

Business in the naval stores market is good and most factors report a satisfactory volume. *Turpentine* is moving in a fair way at 80c. per gal. in 5-drum lots. The *rosin* market is in a fair shape and the "H" grade is quoted at \$7.90 per 280 lb. for less than carlots.

The Iron and Steel Market

PITTSBURGH, Nov. 18, 1921.

Buying of steel products has decreased somewhat and prices are a trifle softer. There is merely a continuation of the new trend that developed at about the middle of October, not so much a decreasing in demand as an arrest of the increase that had been practically continuous for four months.

Fundamental conditions affecting the steel market have not changed for the worse, and in one respect there is an improvement, in that railroad buying on a scale that amounts to something has begun. Superficially the steel market presents an unfavorable appearance, but the condition results from two factors to which no one can object, one being that the increase in demand that resulted from the gradual depletion of stocks ended because the stocks were all liquidated, the other being that requirements of buyers always fall off somewhat toward the close of the year.

The requirements of the country have not decreased and there is no accumulation of steel to be worked off. All the evidence is that the steel made and shipped in recent weeks was actually needed by buyers for their current operations. As long as that is the case the steel industry has not lost ground.

A few thousand freight cars have been contracted for in the past 10 days, and more are in the market. Undoubtedly all orders as placed will be for prompt execution, causing

an immediate demand upon the steel mills for plates and other materials. The absence of car buying for so long a time past has not been due entirely to lack of funds, an important factor having been the impossible prices once asked for cars. Prices of cars are now moderately well liquidated, by car shop wages coming down and labor becoming more efficient, by prices of the various appurtenances getting into reasonable bounds and by steel prices declining farther. Nearly all of the decline in steel prices occurred months ago. Plates for car building would not have cost more than \$5 a ton more on Aug. 1 than they cost now, and that is a small item considering that an ordinary car had advanced from less than \$800 in 1914 to \$3,500 or thereabout in 1920.

Steel ingot production is at a rate between 40 and 45 per cent of capacity, there having been little if any decrease thus far from the 44 per cent rate shown for the month of October. A slight decrease from now to the end of the year is not an improbability, but a rate below 35 per cent is not to be expected. The 20 per cent rate seen last July was a special phenomenon, due to buyers liquidating stocks. Nothing of the sort can occur again unless buyers pile up stocks again.

Naturally there are predictions of decided improvement in the steel trade within the next few months. It has been said that one cannot really foresee the future of the steel industry more than about 6 months ahead, hence when demand is poor one has no reason to allow more than 6 months for a decided improvement. What is reasonably certain is that no very great improvement is to be expected before Feb. 1, because December and January are normally dull on account of the season.

STEEL PRICES

The slight sagging tendency noticed in steel prices, considered as a whole, in the past few weeks is a trifle more pronounced, and prices may be said to have distinctly softened in the past week, although no clear-cut declines have occurred. In not a few commodities it can be said that a carload can now be bought at the price it would have required a 500-ton inquiry to bring out a fortnight ago. Of the entire tonnage of bars, shapes and plates sold in the past week the average was probably nearer 1.60c. than 1.50c., some carload business being done at above 1.60c. In sheets the shading of 3c. for black and 4c. for galvanized is more general, and now it sometimes extends beyond \$2 a ton. On a very attractive order 2.75c. and 3.75c. are distinct possibilities, these being prices that were done freely before the advance at about the middle of September, \$5 a ton.

Tubular goods lists of Sept. 16 are being shaded by the majority of independents. A little shading developed soon after the reduced lists of that time were issued, and this shading has become more widespread rather than deeper. The leading interest maintains the list prices, with the usual qualification as to line pipe. Demand for tubular goods has increased somewhat in the past two or three weeks, in contrast with the condition in steel products generally.

PIG IRON AND COKE

Pig iron, long presenting a stagnant market, is now showing a disposition to yield in price whenever any competitive business of importance arises. Southern foundry has dropped from \$19 to \$18 Birmingham. In the local market, a buyer of a few hundred tons of foundry secured a price of \$20.50 valley, the market previously having been largely nominal at \$21. Basic is still quoted by furnaces at \$19 valley, but resale iron seems to be available at enough below this to attract orders away from furnaces. Bessemer is steady at \$20 valley, the price for more than three months.

Connellsville coke prices have weakened on account of an obvious overproduction, due to operators blowing in ovens on a too optimistic appraisal of the increase in demand, and in the past two weeks merchant ovens have been returning to the idle list. Spot coke is about \$3@3.15 for furnace and \$4@4.50 for foundry, being off in the week 10c. or 15c. in furnace and 25c. in foundry.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.40 - \$0.45
Acetone.....lb.	\$0.121 - \$0.121	.13 - .131
Acid, acetic, 28 per cent.....100 lbs.	2.75 - 3.00	3.25 - 3.50
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25	6.50 - 7.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.00 - 10.50	10.75 - 11.00
Boric, crystals.....lb.	.121 - .121	.13 - .131
Boric, powder.....lb.	.13 - .131	.14 - .141
Citric.....lb.		.45 - .47
Hydrochloric.....100 lb.	1.25 - 1.50	1.60 - 1.75
Hydrofluoric, 52 per cent.....lb.	.12 - .121	.13 - .131
Lactic, 44 per cent tech.....lb.	.09 - .10	.101 - .12
Lactic, 22 per cent tech.....lb.	.04 - .051	.06 - .07
Molybdic, C.P.....lb.	3.25 - 3.50	3.60 - 4.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	.061 - .061	.061 - .07
Nitric, 42 deg.....lb.	.061 - .07	.071 - .071
Oxalic, crystals.....lb.	.13 - .131	.14 - .15
Phosphoric, 50 per cent solution.....lb.	.13 - .131	.14 - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.		1.90 - 2.00
Sulphuric, 60 deg., tank cars.....ton		11.00 - 12.00
Sulphuric, 60 deg., drums.....ton		13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	17.00 - 18.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	21.00 - 22.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	23.00 - 23.50	24.00 - 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	.75 - .85	
Tannic (tech.).....lb.	.45 - .48	.50 - .55
Tartaric, imported crystals.....lb.		.261 - .271
Tartaric acid, imported, powdered.....lb.		.271 - .281
Tartaric acid, domestic.....lb.		.35 - .35
Tungstic, per lb. of WO.....lb.		1.10 - 1.20
Alcohol, Ethyl.....gal.		4.65 - 5.00
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof.....gal.		.37 - .38
Alcohol, denatured, 190 proof.....gal.		.35 - .36
Alum, ammonia, lump.....lb.	.031 - .031	.04 - .041
Alum, potash, lump.....lb.	.031 - .04	.041 - .041
Alum, chrome lump.....lb.	.081 - .081	.081 - .09
Aluminum sulphate, commercial.....lb.	.011 - .02	.021 - .021
Aluminum sulphate, iron free.....lb.	.021 - .03	.031 - .031
Aqua ammonia, 26 deg. drums (750 lb.).....lb.	.071 - .071	.08 - .081
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.31 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.07 - .071	.08 - .09
Ammonium chloride, granular (white sal ammoniac).....lb.	.07 - .071	.071 - .071
Ammonium chloride, granular (gray sal ammoniac).....lb.	.07 - .071	.071 - .071
Ammonium nitrate.....lb.	.071 - .071	.071 - .081
Amylacetate tech.....gal.		2.40 - 2.70
Arsenic oxide, (white arsenic) powdered.....lb.	.061 - .061	.061 - .07
Arsenic, sulphide, powdered (red arsenic).....lb.	.11 - .111	.12 - .13
Barium chloride.....ton	58.00 - 60.00	62.00 - 70.00
Barium dioxide (peroxide).....lb.	.20 - .21	.22 - .23
Barium nitrate.....lb.	.071 - .071	.08 - .081
Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .041	.041 - .05
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Bromine (see sulphur, roll).....lb.	.27 - .28	.281 - .30
Bromine.....lb.		
Calcium acetate.....100 lbs.	1.75 - 2.00	
Calcium carbide.....lb.	.041 - .041	.05 - .051
Calcium chloride, fused, lump.....ton	23.50 - 24.00	24.50 - 25.50
Calcium chloride, granulated.....lb.	.011 - .02	.021 - .021
Calcium hypochloride (bleach g powder) 100 lb.	2.25 - 2.30	2.35 - 3.00
Calcium peroxide.....lb.		1.40 - 1.50
Calcium phosphate, tribasic.....lb.		.15 - .16
Camphor.....lb.		.85 - .90
Carbon bisulphide.....lb.	.061 - .061	.07 - .071
Carbon tetrachloride, drums.....lb.	.101 - .101	.11 - .12
Carbonyl chloride, (phosgene).....lb.		.60 - .75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.091 - .10
Chloroform.....lb.		.40 - .45
Cobalt oxide.....lb.		2.00 - 2.10
Copperas (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	.20 - .201	.21 - .22
Copper cyanide.....lb.		.50 - .62
Copper sulphate, crystals.....lb.	.05 - .051	.051 - .06
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		.80 - .93
Ethyl Acetate pure (acetic ether, 98% to 100%).....gal.		.95 - .121
Formaldehyde, 40 per cent.....lb.	.11 - .111	.111 - .121
Fusel oil, ref.....gal.		2.50 - 3.00
Fusel oil, crude.....gal.		1.50 - 1.75
Glauber's salt (see sodium sulphate).....lb.		
Glycerine, C. P. drums extra.....lb.		.141 - .15
Iodine, resublimed.....lb.		3.50 - 3.60
Iron oxide, red.....lb.		.12 - .18
Iron sulphate (copperas).....ton	18.00 - 19.00	20.00 - 23.00
Lead acetate.....lb.		.101 - .121
Lead arsenate, powd.....lb.	.15 - .151	.151 - .161
Lead nitrate.....lb.		.15 - .20
Litharge.....lb.	.071 - .08	.081 - .09
Lithium carbonate.....lb.		1.40 - 1.50
Magnesium carbonate, technical.....lb.	.08 - .081	.09 - .10
Magnesium sulphate, U. S. P.....100 lb.	2.50 - 2.75	
Magnesium sulphate, technical.....100 lb.		1.10 - 1.75
Methanol, 95%.....gal.		.66 - .68
Methanol, 97%.....gal.		.70 - .72
Nickel Salt, double.....lb.		.12 - .121
Nickel salt, single.....lb.		.14 - .141
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	.40 - .41	.42 - .45
Phosphorus, yellow.....lb.		.30 - .35
Potassium bichromate.....lb.	.11 - .111	.111 - .12

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar) . . . lb.	\$. . . \$. . .	\$0.28 - \$0.30
Potassium bromide, granular . . . lb.		.15 - .20
Potassium carbonate, U. S. P. . . lb.	.15 - .16	.17 - .20
Potassium carbonate, 80-85% . . lb.	.04 - .04	.05 - .05
Potassium chlorate, crystals . . lb.	.06 - .06	.07 - .12
Potassium cyanide . . . lb.		.40 - .45
Potassium hydroxide (caustic potash) . . lb.	.05 - .06	.06 - .08
Potassium iodide . . . lb.		2.60 - 2.75
Potassium nitrate . . . lb.	.07 - .07	.08 - .09
Potassium permanganate . . . lb.	.19 - .20	.21 - .22
Potassium prussiate, red . . . lb.	.28 - .29	.29 - .30
Potassium prussiate, yellow . . lb.	.21 - .21	.21 - .22
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake (bulk) . . . ton		20.00 - 22.00
Silver cyanide . . . oz.		1.35 - 1.38
Silver nitrate . . . oz.		.46 - .47
Soda ash, light . . . 100 lb.	2.00 - 2.10	2.15 - 2.50
Soda ash, dense . . . 100 lb.	2.35 - 2.40	2.45 - 2.70
Sodium acetate . . . lb.	.04 - .04	.05 - .05
Sodium bicarbonate . . . 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium bichromate . . . lb.	.08 - .08	.08 - .08
Sodium bisulphate (nitre cake) . . ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P. . lb.	.04 - .05	.05 - .06
Sodium borate (borax) . . . lb.	.05 - .06	.06 - .07
Sodium carbonate (sal soda) . . 100 lb.	1.80 - 1.90	2.00 - 2.20
Sodium chlorate . . . lb.	.07 - .07	.08 - .08
Sodium cyanide . . . lb.	.28 - .28	.29 - .30
Sodium fluoride . . . lb.	.11 - .12	.12 - .14
Sodium hydroxide (caustic soda) . . 100 lb.	4.00 - 4.10	4.15 - 4.50
Sodium hypsulphite . . . lb.		.03 - .03
Sodium nitrite . . . lb.	.06 - .07	.07 - .07
Sodium peroxide, powdered . . lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic . . lb.	.04 - .04	.04 - .05
Sodium potassium tartrate (Rochelle salts) . lb.		.21 - .24
Sodium prussiate, yellow . . . lb.	.14 - .14	.14 - .15
Sodium silicate, solution (40 deg.) . . 100 lb.	.95 - 1.00	1.10 - 1.25
Sodium silicate, solution (60 deg.) . . 100 lb.	2.30 - 2.40	2.45 - 3.00
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.04 - .04	.05 - .05
Sodium sulphite, crystals . . lb.	.03 - .03	.04 - .04
Strontium nitrate, powdered . . lb.	.13 - .14	.14 - .14
Sulphur, crude . . . ton	18.00 - 20.00	.09 - .10
Sulphur dioxide, liquid, cylinders extra . lb.		2.25 - 3.10
Sulphur (sublimed), flour . . . 100 lb.		2.00 - 2.75
Sulphur, roll (brimstone) . . . 100 lb.		.09 - .10
Tin bichloride . . . lb.	.09 - .09	.37 - .38
Tin oxide . . . lb.		.17 - .17
Zinc carbonate, precipitate . . lb.	.16 - .16	.09 - .10
Zinc chloride, gran . . . lb.	.09 - .09	.45 - .47
Zinc cyanide . . . lb.	.42 - .44	.11 - .12
Zinc dust . . . lb.	.11 - .11	.08 - .09
Zinc oxide, XX . . . lb.	.07 - .07	3.00 - 3.50
Zinc sulphate . . . 100 lb.	3.00 - 3.25	

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude . . . lb.	\$1.10 - \$1.15
Alpha-naphthol, refined . . . lb.	.27 - .30
Alpha-naphthylamine . . . lb.	.18 - .20
Aniline oil, drums extra . . . lb.	.24 - .26
Aniline salts . . . lb.	.75 - 1.00
Anthracene, 80% in drums (100 lb.) . . lb.	1.35 - 1.45
Benzaldehyde U.S.P. . . lb.	.90 - 1.00
Benzidine, base . . . lb.	.75 - .85
Benzidine sulphate . . . lb.	.62 - .65
Benzoic acid, U.S.P. . . lb.	.52 - .55
Benzoate of soda, U.S.P. . . lb.	.27 - .32
Benzene, pure, water-white, in drums (100 gal.) . gal.	.25 - .28
Benzene, 90% in drums (100 gal.) . . gal.	.25 - .27
Benzyl chloride, 95-97% refined . . lb.	.20 - .23
Benzyl chloride, tech . . . lb.	3.75 - 4.00
Beta-naphthol benzoate . . . lb.	.70 - .75
Beta-naphthol, sublimed . . lb.	.30 - .34
Beta-naphthol, tech . . . lb.	1.75 - 1.85
Beta-naphthylamine, sublimed . . lb.	.16 - .17
Cresol, U. S. P., in drums (100 lb.) . . lb.	.25 - .27
Ortho-cresol, in drums (100 lb.) . . lb.	.70 - .80
Cresylic acid, 97-99% straw color, in drums . gal.	.65 - .70
Cresylic acid, 75-97% dark, in drums . gal.	.45 - .50
Cresylic acid, 50% first quality, drums . gal.	.06 - .09
Dichlorobenzene . . . lb.	1.00 - 1.10
Diethylaniline . . . lb.	.45 - .60
Dimethylaniline . . . lb.	.23 - .27
Dinitrobenzene . . . lb.	.20 - .25
Dinitrochlorobenzene . . . lb.	.30 - .35
Dinitronaphthalene . . . lb.	.35 - .40
Dinitrophenol . . . lb.	.25 - .30
Dinitrotoluene . . . lb.	.30 - .35
Dip oil, 25% ear lots, in drums . . gal.	.60 - .70
Diphenylamine . . . lb.	1.00 - 1.10
H-acid . . . lb.	1.15 - 1.20
Meta-phenylenediamine . . lb.	.12 - .14
Monochlorobenzene . . . lb.	1.65 - 1.70
Monothylaniline . . . lb.	.06 - .08
Naphthalene crushed, in bbls . . lb.	.06 - .08
Naphthalene, flake . . . lb.	.08 - .09
Naphthalene, balls . . . lb.	.70 - .75
Naphthionic acid, crude . . lb.	.12 - .15
Nitrobenzene . . . lb.	.30 - .35
Nitro-naphthalene . . . lb.	.15 - .17
Nitro-toluene . . . lb.	3.00 - 3.10
Ortho-amidophenol . . . lb.	.15 - .20
Ortho-dichlor-benzene . . lb.	.75 - .80
Ortho-nitro-phenol . . . lb.	.15 - .20
Ortho-nitro-toluene . . . lb.	.20 - .25
Ortho-toluidine . . . lb.	1.40 - 1.45
Para-amidophenol, base . . lb.	1.70 - 1.80
Para-amidophenol, HCl . . lb.	.12 - .15
Para-dichlorobenzene . . lb.	.75 - .80
Para-nitroaniline . . . lb.	.80 - .85
Para-nitrotoluene . . . lb.	1.70 - 1.75
Para-phenylenediamine . . lb.	1.25 - 1.40
Para-toluidine . . . lb.	.40 - .50
Phthalic anhydride . . . lb.	

Phenol, U. S. P., drums . . . lb.	.10 - .12
Pyridine . . . gal.	2.00 - 3.50
Resorcinol, technical . . . lb.	1.50 - 1.60
Resorcinol, pure . . . lb.	2.00 - 2.25
Salicylic acid, tech., in bbls . . lb.	.20 - .21
Salicylic acid, U. S. P. . . lb.	.22 - .23
Salol . . . lb.	.70 - .72
Solvent naphtha, water-white, in drums, 100 gal. . gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal. . gal.	.14 - .16
Sulphanilic acid, crude . . . lb.	.27 - .30
Tolidine . . . lb.	1.30 - 1.35
Toluidine, mixed . . . lb.	.43 - .45
Toluene, in tank cars . . . gal.	.25 - .28
Toluene, in drums . . . gal.	.28 - .31
Xylenes, drums, 100 gal. . . lb.	.40 - .45
Xylene, pure, in drums . . . gal.	.40 - .45
Xylene, pure, in tank cars . . gal.	.45 - .45
Xylene, commercial, in drums, 100 gal. . gal.	.33 - .35
Xylene, commercial, in tank cars . gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Bayberry Wax . . . lb.	\$0.20 - \$0.21
Beeswax, refined, dark . . . lb.	.24 - .25
Beeswax, refined, light . . . lb.	.28 - .30
Beeswax, white pure . . . lb.	.34 - .38
Candelilla wax . . . lb.	.25 - .25
Carnauba, No. 1 . . . lb.	.45 - .46
Carnauba, No. 2, North Country . lb.	.23 - .23
Carnauba, No. 3, North Country . lb.	.14 - .15
Japan . . . lb.	.21 - .21
Montan, crude . . . lb.	.04 - .04
Paraffine waxes, crude match wax (white) 105-110 m.p. . . lb.	.04 - .04
Paraffine waxes, crude, scale 124-126 m.p. . lb.	.03 - .04
Paraffine waxes, refined, 118-120 m.p. . lb.	.04 - .04
Paraffine waxes, refined, 125 m.p. . . lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p. . lb.	.04 - .04
Paraffine waxes, refined, 133-135 m.p. . lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p. . lb.	.05 - .06
Stearic acid, single pressed . . lb.	.09 - .09
Stearic acid, double pressed . . lb.	.09 - .09
Stearic acid, triple pressed . . lb.	.10 - .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls.; gross weight, 500 lb.

Rosin B-D, bbl. 280 lb.	\$5.80 - 5.80
Rosin E-I 280 lb.	5.85 - 5.90
Rosin K-N 280 lb.	6.40 - 6.85
Rosin W. G.-W. W. . . . 280 lb.	7.10 - 7.30
Wood rosin, bbl. 280 lb.	6.25 - . . .
Spirits of turpentine . . . gal.	.82 - . . .
Wood turpentine, steam dist. . gal.	.80 - . . .
Wood turpentine, dest. dist. . gal.	.78 - . . .
Pine tar pitch, bbl. 200 lb.	. . . - 6.75
Tar, kiln burned, bbl. (500 lb.) . bbl.	. . . - 10.50
Retort tar, bbl. 500 lb.	. . . - 10.50
Rosin oil, first run . . . gal.	.36 - . . .
Rosin oil, second run . . . gal.	.39 - . . .
Rosin oil, third run . . . gal.	.46 - . . .
Pine oil, steam dist., sp.gr. 0.930-0.940 . gal.	\$1.90 - . . .
Pine oil, pure, dest. dist. . . gal.	1.50 - . . .
Pine tar oil, ref., sp.gr. 1.025-1.035 . gal.	.46 - . . .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. . gal.	.35 - . . .
Pine tar oil, double ref., sp.gr. 0.965-0.990 . gal.	.75 - . . .
Pine tar, ref., thin, sp.gr. 1.080-1.960 . gal.	.35 - . . .
Turpentine, crude, sp. gr. 0.900-0.970 . gal.	1.25 - . . .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990 . gal.	.35 - . . .
Pinewood creosote, ref. . . . gal.	.52 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.) . . . gal.	\$0.37 - . . .
70-72 deg., steel bbls. (85 lb.) . . . gal.	.35 - . . .
68-70 deg., steel bbls. (85 lb.) . . . gal.	.34 - . . .
V. M. and P. naphtha, steel bbls. (85 lb.) . gal.	.23 - . . .

Fertilizers

Ammonium sulphate, bulk and d. bags . . 100 lb.	\$2.60 - 2.90
Blood, dried, f.o.b., N. Y . . . unit	4.00 - . . .
Bone, 3 and 50, ground, raw . . . ton	30.00 - 32.00
Cyanamide, f.o.b. works . . . unit	4.50 - . . .
Fish scrap, dom., dried, f.o.b. works . . unit	2.90 - 3.00
Nitrate soda . . . 100 lb.	2.40 - 2.45
Tankage, high grade, f.o.b. Chicago . . unit	3.00 - 3.10
Phosphate rock, f.o.b. mines, Florida pebble, 68-72 p.c. . . ton	4.50 - 6.50
Tennessee, 78-80 p.c. . . ton	8.50 - 9.00
Potassium muriate, 80 p.c. . . ton	37.00 - 40.00
Potassium sulphate . . . unit	1.00 - 1.10

Crude Rubber

Para-Upriver fine . . . lb.	\$0.23 - .23
Upriver coarse . . . lb.	.13 - .14
Upriver cauchó ball . . . lb.	.13 - .14
Plantation—First latex crepe . . lb.	.18 - .18
Ribbed smoked sheets . . . lb.	.18 - .18
Brown crepe, thin, clean . . lb.	.18 - . . .
Amber crepe No. 1 . . . lb.	.19 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls . . . lb.	\$0.10 - \$0.10
Castor oil, AA, in bbls . . . lb.	.11 - .12
China wood oil, in bbls. (f.o.b. Pac. coast) . lb.	.13 - .13
Cocanut oil, Ceylon grade, in bbls . . lb.	.09 - .09
Cocanut oil, Cochín grade, in bbls . . lb.	.10 - .10
Corn oil, crude, in bbls . . . lb.	.09 - .09
Cottonseed oil, crude (f. o. b. mill) . . lb.	.06 - .07
Cottonseed oil, summer yellow . . lb.	.08 - .08
Cottonseed oil, winter yellow . . lb.	.09 - .09

Linseed oil, raw, ear lots (domestic).....	gal.	67	—	68
Linseed oil, raw, tank cars (domestic).....	gal.	62	—	63
Linseed oil, in 5-bbl lots (domestic).....	gal.	70	—	71
Olive oil, Denatured.....	gal.	\$1.15	—	\$1.20
Palm, Lagos.....	lb.	.07	—	.08
Palm, Niger.....	lb.	.06	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.08	—	.08
Peanut oil, refined, in bbls.....	lb.	.11	—	.11
Rapeseed oil, refined, in bbls.....	gal.	.84	—	.86
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls N. Y.....	lb.	.08	—	.08
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.07	—	.07

FISH

Light pressed menhaden.....	gal.	\$0.40	—	....
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.45	—	....
Blown menhaden.....	gal.	.48	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$23.50	—	28.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	20.00	—	24.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	23.00	—	24.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blane fixe, dry.....	lb.	.04	—	.04
Blane fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.07	—	.10
Chalk, Precipitated, domestic, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, domestic, light.....	lb.	.04	—	.04
Chalk, Precipitated, domestic, heavy.....	lb.	.03	—	.04
Chalk, Precipitated, English, extra light.....	lb.	.04	—	.05
Chalk, Precipitated, English, light.....	lb.	.04	—	.05
Chalk, Precipitated, English, dense.....	lb.	.04	—	.04
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	6.50	—	8.50
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	9.00	—	10.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	13.00	—	20.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	13.00	—	20.00
China clay (kaolin), imported, lump.....	net ton	12.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	25.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	net ton	5.00	—	7.50
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.06	—	.07
Graphite, Ceylon chip.....	lb.	.04	—	.05
Graphite, high grade amorphous crude.....	lb.	.001	—	.02
Kieselguhr, f.o.b. mines, Cal.....	per ton	40.00	—	....
Kieselguhr, f.o.b. N. Y.....	per ton	55.00	—	60.00
Magnesia, calcined.....	per ton	60.00	—	65.00
Pumice stone, imported.....	lb.	.03	—	.40
Pumice stone, domestic, lump.....	lb.	.05	—	.05
Pumice stone, domestic, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.68	—	.70
Shellac, orange superfine.....	lb.	.78	—	.80
Shellac, A. C. garnet.....	lb.	.58	—	.60
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	7.50	—	11.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	25.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$50.00	—	....
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	52-55	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30-32	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in ear lots, f.o.b. Eastern shipping points.....	net ton	33-35	—	....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	35-40	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30-35	—	....
Magnesite brick, 9-in. straight.....	net ton	65-70	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77	—	....
Magnesite brick, soaps and splits.....	net ton	98	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	40-42	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	42-45	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35-38	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.11	—	....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.11	—	.12
Ferromanganese, 76-80% Mn, domestic.....	gross ton	58.00	—	60.00
Ferromanganese, 76-80% Mn, English & German.....	gross ton	58.00	—	59.00
Spiegelisen, 18-22% Mn.....	gross ton	25.00	—	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.25	—	....
Ferrosilicon, 10-15%.....	gross ton	38.00	—	40.00
Ferrosilicon, 50%.....	gross ton	57.00	—	59.00
Ferrosilicon, 75%.....	gross ton	120.00	—	125.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.40	—	.45
Ferroumranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	4.25	—	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	net ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min.....	ton	22.00	—	23.00
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	ton	22.00	—	23.00
Coke, foundry, f.o.b. ovens.....	net ton	4.25	—	4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.50
Fluorspar, gravel, f.o.b. mines, New Mexico.....	net ton	15.00	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.23	—	.24
Manganese ore, chemical (MnO ₂).....	net ton	55.00	—	60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.45	—	.50
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.12	—	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.13	—	.13
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.11	—	.12
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.50	—	2.75
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	2.75	—	3.00
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.25	—	1.75
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00	—	....
Zircon, washed, iron free, f.o.b. Pablo, Florida.....	lb.	.04	—	.13

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.25
Aluminum, 98 to 99 per cent.....	24.50@25.00
Antimony, wholesale lots, Chinese and Japanese.....	4.80@5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, shot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	28.875
Lead, New York, spot.....	4.65@4.70
Lead, E. St. Louis, spot.....	4.35
Zinc, spot, New York.....	5.15
Zinc, spot, E. St. Louis.....	4.70

OTHER METALS

Silver (commercial).....	oz.	\$0.67
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	85.00
Iridium.....	oz.	150.00@170.00
Palladium.....	oz.	55.00-60.00
Mercury.....	75 lb.	40.00-41.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	19.00@19.75
High brass wire.....	16.75
High brass rods.....	14.25
Low brass wire.....	18.25
Low brass rods.....	18.75
Brass tubing.....	25.00
Brass bronze tubing.....	29.75
Seamless copper tubing.....	19.50
Seamless high brass tubing.....	18.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.75@10.25	9.25	9.50
Copper, heavy and wire.....	9.25@9.50	8.50	8.50
Copper, light and bottoms.....	7.50@8.00	7.50	7.25
Lead, heavy.....	3.50@3.75	3.25	3.25
Lead, tea.....	2.25@2.35	2.25	2.25
Brass, heavy.....	4.25@4.50	4.50	5.00
Brass, light.....	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.00@4.25	4.25	4.50
Zinc.....	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. of structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.88	\$2.88	\$2.88
Soft steel bars.....	2.78	2.78	2.78
Soft steel bar shapes.....	2.78	2.78	2.78
Soft steel bands.....	3.42	3.48	3.48
Plates, 1/2 to 1 in. thick.....	2.88	2.88	2.88

*Add 15¢ per 100 lb. for trucking to Jersey City and 10¢ for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

OAKLAND—The American Petroleum Co., 343 Sansom St., San Francisco, has awarded a contract to Hannah Bros., 142 Sansom St., for the erection of a 2-story plant on the waterfront at Oakland, estimated to cost close to \$25,000. Carl Werner, Humboldt Bank Bldg., San Francisco, is architect.

LOS ANGELES—Fire, Nov. 4, destroyed a portion of the plant of the Elaterite Co., manufacturer of rubber composition products, entailing a loss which is estimated at about \$85,000.

OAKLAND—The National Lead Co., 485 California St., San Francisco, Cal., has awarded a contract to the Cahill-Vensano Co., 110 Suter St., for the erection of a 3-story plant at East 10th St. and 41st Ave., Oakland, to cost \$49,000.

Connecticut

PLAINVILLE—The Plainville Castings Co. has awarded a contract to the Torrington Building Co., Torrington, Conn., for the erection of a 1-story brick addition, 62 x 160 ft.

BRIDGEPORT—The Crane Co., manufacturer of steam specialties, metal products, etc., is taking bids and will soon award contract for the erection of a 1-story addition to its local plant on South Ave. It will be 75 ft. x 175 ft., and will be used for the most part as an annealing works. The installation will comprise 10 new annealing furnaces, oil-fired, with auxiliary operating equipment.

Florida

FERNANDINA—The Florida Terminal Co. is perfecting plans for the erection of a new analytical chemical laboratory for phosphate and other analysis. It will be equipped with crushing machinery, pulverizing machinery, and general operating apparatus. Ernest Molnar is chemist for the company; R. M. Martin is plan superintendent.

Illinois

ELGIN—The Woodruff & Edwards Co., manufacturer of metal castings, etc., has awarded a contract to the Illinois Hydraulic Stone & Construction Co., 24 South 21st St., for the erection of a new 1-story foundry addition, 50 x 100 ft., to cost about \$15,000.

CHICAGO—The Diamond Red Paint Co., 2750 North Lincoln St., is taking bids for the erection of a 1-story side addition at its plant, 30 x 80 ft. Frederick C. Telch, 305 South La Salle St., is architect.

Louisiana

GRETN—The United States Flour Milling Co., Kansas City, Mo., is planning for the construction of a new branch plant at Gretna. Work will be commenced at an early date.

Maryland

BALTIMORE—The American Oil Co., American Bldg., is considering the construction of a new 1- and 2-story building on Haines St., 130 x 300 ft., estimated to cost in excess of \$250,000.

BALTIMORE—The Chesapeake Paper Board Co., Key Highway, is perfecting details for enlargements in its plant to increase the output from 50,000 to 100,000 lb. of paper board products per day. Considerable new machinery will be installed, estimated to cost close to \$50,000. A new power house will be constructed. J. S. Smith is president.

BALTIMORE—Richard K. Meade & Co., 11 East Fayette S., engineers, have plans well under way for the proposed lime plant to be erected at the paper and pulp mills of the Bathurst Co., Ltd., Bathurst, New Brunswick, N. S. The plant will include two large kilns, provided with automatic stokers and operating under induced draft. A platform elevator for limestone handling will be installed.

Massachusetts

BOSTON—The Revere Sugar Refinery, 327-53 Medford St., has filed plans for the erection of a 1-story melter plant addition at its works.

BOSTON—The Eastern Salt Co., care of Shepard & Stearns, 65 Franklin St., architects, has awarded a contract to the Scully Co., 118 First St., Cambridge, Mass., for the erection of a new 1-story building.

ARLINGTON—The Frost Insecticide Co., 20 Mill St., has awarded a contract to the Holt-Fairchild Co., 248 Boylston St., Boston, for the erection of a 1-story building at its plant, 45 x 100 ft., to cost about \$40,000. Work will be placed under way at once.

Michigan

MOUNT PLEASANT—The National Portland Cement Co., 516 Book Bldg., Detroit, will defer the erection of its proposed new 2-story cement mill on Coldwater Lake, near Mount Pleasant, until early in the coming year. Preliminary plans are being drawn. The plant is estimated to cost close to \$500,000, including machinery. H. C. Shields is manager.

PORT HURON—The Port Huron Sulphite & Paper Co. will commence the immediate construction of additions to its paper mill to cost in the neighborhood of \$750,000 with machinery.

ST. JOSEPH—The Industrial Rubber Co. is said to be planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at \$65,000.

OTSEGO—The Mac Sim Bar Paper Co. will call for bids before the close of the month for the construction of its proposed new 1-story power plant for paper mill service, 85 x 140 ft., estimated to cost about \$300,000 with machinery. Billingham & Cobb, Press Bldg., Kalamazoo, Mich., are architects. A. B. Thomas is president and general manager.

CHEBOYGAN—The Cheboygan Tile & Roofing Co. has commenced production at its new local plant and plans for extensive operations. The plant will be devoted to the manufacture of brick and tile products, and it is proposed to develop an output of about 30,000 bricks and tiles per day. The company has secured large clay properties in this section.

Minnesota

MANKATO—The Carney Cement Co. will defer further work on the construction of additions to its local mills, foundations for which recently have been laid. A total of eight buildings will be erected, and plans for the superstructures have been drawn. It is expected to proceed with the expansion as soon as conditions in the industry warrant. Richard K. Meade & Co., 11 East Fayette St., Baltimore, Md., are engineers.

Montana

MILES CITY—The Miles City Refining Co. has preliminary plans under way for the construction of a new oil refinery to cost about \$40,000. R. H. Daniels is secretary.

New Jersey

LINDEN—The Warner-Quinlan Co., 79 Wall St., New York, has commissioned George Gifford, engineer, 227 Fulton St., New York, to prepare plans for the rebuilding of its asphalt refining plant at Linden, recently destroyed by fire with loss estimated at close to \$2,000,000, including tanks, stills, manufacturing and mechanical buildings, power plant, etc. W. W. McFarland is general manager.

New York

NEW YORK—Goldberger Bros., 842 Third Ave., manufacturers of plate glass, have leased the 5-story building at 27th St. and First Ave., on site 74 x 95 ft., comprising about 30,000 sq.ft. of floor area, for a new works.

OGDENSBURG—The Bob White Chemical Co., 39 Broadway, New York, has completed plans for extensions and improvements in its plant at Ogdensburg, 1-story and basement, 80 x 145 ft., to cost about

\$25,000. The work will include laboratory enlargement. W. T. Smith is vice-president.

Ohio

WOOSTER—The Wooster Rubber Co. has preliminary plans under way for the erection of a 2-story plant, 40 x 85 ft.

Oklahoma

OKMULGEE—The Interstate Glass Co. is considering the erection of a new plant to cost about \$100,000, including machinery. H. J. Walter is president.

Pennsylvania

SCRANTON—The Diamond Oil & Paint Co., 211-19 South Seventh Ave., has awarded a contract to the R. D. Richardson Construction Co., Connell Bldg., for the erection of its proposed 2-story building on Seventh Ave., estimated to cost close to \$60,000. Edward J. Lynott is president.

ERIE—The Keystone Rubber Mfg. Co., 1413 East 11th St., has commenced the rebuilding of its plant destroyed by fire several months ago. It will be 3-story, 65 x 125 ft., located at 11th and French Sts. A. W. Tuttle, 618 East Seventeenth Ave., is the building contractor. Joseph B. Mooney is president.

SHARON—The Carnegie Steel Co., Pittsburgh, has commenced the dismantling of its local plant, comprising 6 basic open-hearth furnaces, heating furnaces, blooming and finishing mills. The blast furnace at the site will be left intact. The plant has been closed since May 1st of last year and under normal operations gave employment to about 700 men. The equipment will be used by the company at its other works.

Rhode Island

PROVIDENCE—The Charles S. Tanner Co., 250 South Water St., manufacturer of starch, etc., will break ground at once for the erection of its new 2-story plant, 50 x 76 ft., at South Water and Coin Sts.

Tennessee

CHATTANOOGA—The Southern Cotton & Paper Co. has plans under way for the erection of a 1-story plant, 50 x 160 ft., on site recently acquired, totalling about 2 acres of land. The mill will be equipped to specialize in the manufacture of bond and other papers from cotton linters, with initial daily output of about 15 tons. Mercer Reynolds heads the company.

Texas

ROCKDALE—G. C. Holmes & Co., Houston, have presented a proposition to the local Chamber of Commerce for the erection of an oil-refining plant, the cost to be equally divided between the two interests.

Washington

SPOKANE—The Consolidated Diamond Oil & Refining Co., with temporary offices in the Spokane Hotel, is arranging for the early construction of a new refinery on property acquired at Dishman, near Spokane.

SEATTLE—The Washington Cord Tire Co. has acquired a site totalling about 10 acres of land at Vancouver, Wash., for the erection of a new plant for the manufacture of automobile tires and other rubber products. F. C. Plouf is president.

West Virginia

RICHHOOD—The Cherry River Paper Co. has broken ground for the erection of a 1-story and basement power plant for general paper mill service, 40 x 150 ft., estimated to cost in excess of \$250,000. George Snyder is assistant superintendent.

Wisconsin

MILWAUKEE—The American Hide & Leather Co., 14th St., is having plans prepared by Lockwood, Greene & Co., 38 South Dearborn St., Chicago, Ill., engineers, for the rebuilding of its local tannery on Commerce St., recently destroyed by fire with loss in excess of \$200,000.

Weightman & Steigley, 3420 Parker Ave., Chicago, are preparing plans for a group of buildings for a canning factory in northern Wisconsin to cost a total of \$250,000. The buildings include a 2-story building, 96 x 48; a 1-story building 36 x 38, a 1-story building 60 x 60, one boiler house 32 x 32 to contain high pressure boiler for process steam for cooking purposes. Other buildings will include a two-section warehouse, each section 96 x 48, two stories in height, and one reinforced-concrete antiseptic tank. The architects are receiving bids for these structures, as well as the apparatus to be used in the process.

New Companies

THE PRODUCERS PAPER CO., 208 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$32,000, to manufacture paper products. The incorporators are Robert J. Magill, R. W. and Herbert S. Nock.

THE GENERAL GALVANIZING CORP., New York, N. Y., has been incorporated with a capital of \$50,000, to manufacture galvanized metal products. The incorporators are A. Ross, C. and L. Pervitall. The company is represented by Henry Gerson, 30 East 42d St.

THE KEAN LEATHER CO., Woburn, Mass., has been incorporated with a capital of \$50,000, to manufacture leather products. Carl R. Bedell is president; and Frederick C. Kean, 40 Arlington Rd., Woburn, treasurer.

THE CALIFORNIA-CAROLINA OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000, to manufacture petroleum products. The incorporators are J. L. Bird, W. A. Love, and Carlisle Williams. The company is represented by W. and L. M. Chapman, 1015 Citizens' National Bank Bldg., Los Angeles.

THE HABERLAND MFG. CO., Jersey City, N. J., has been incorporated with a capital of \$1,200,000, to manufacture chemicals and chemical byproducts. The incorporators are Paul Haberland, William H. Fain and Paul C. Whipp. The company is represented by the United States Corporation Co., 15 Exchange Pl., Jersey City.

THE TUCKER WATERPROOFING & INSULATING CO., Brockton, Mass., has been incorporated with a capital of \$95,000, to manufacture insulation specialties, waterproofing products, etc. William R. Tucker is president; and George Tucker, Brockton, treasurer.

THE ILLMO OIL CO., Murphy Bldg., East St. Louis, Ill., has been incorporated with a capital of \$25,000, to manufacture oil products. The incorporators are Edward C. and William F. Friedewald, and Thomas B. Edwards.

THE STAR DUST PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$100,000, to manufacture composition mineral products. The incorporators are J. Andrews, Jr., D. Worth and E. Freeman. The company is represented by Pease & Mason, 120 Broadway, New York.

THE CHEMICAL OIL REFINING CO., Wilmington, Del., has been incorporated under state laws with capital of \$300,000, to manufacture refined oil products. The company is represented by the Colonial Charter Co., Ford Bldg., Wilmington.

THE AMERICAN PRODUCTS CO., Jacksonville, Fla., has been incorporated with a capital of \$1,000,000, to manufacture chemicals and chemical byproducts. B. F. Williamson is president, and J. T. McCarthy, vice-president, both of Gainesville, Fla.

THE NOTTINGHAM RUBBER CO., Trenton, N. J., has been incorporated with a capital of \$500,000, to manufacture rubber products. The incorporators are Samuel H. Bell, I. Alexander and C. Francis Fisk, 150 East State St., Trenton.

THE NORTHERN PENNSYLVANIA CHEMICAL CO., Coudersport, Pa., has been incorporated under Delaware laws with capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are E. P. Huntington and J. T. Mansfield, Coudersport; and Frederick Walker, Knoxville, Pa. The company is represented by the Capital Trust Co., Dover, Del.

THE HATHAWAY OIL CO., New Bedford, Mass., has been incorporated with a capital of \$30,000, to manufacture oil products. John M. Hathaway is president, and R. Eugene Ashley, New Bedford, treasurer.

THE TRUAMAN FERTILIZER CO., Jacksonville, Fla., has been incorporated with a capital of \$200,000, to manufacture fertilizer products. R. B. Truaman is president; J. J. McGrath, vice-president; and G. R. Needham, secretary-treasurer, all of Jacksonville.

THE BRAENDER RUBBER & TIRE CO., Wilmington, Del., has been incorporated under state laws with capital of \$1,100,000, to manufacture automobile tires and other rubber products. The company is represented by the Corporation Trust Co. of America, du Pont Bldg., Wilmington.

THE SUSH LEATHER CO., New York, N. Y., has been incorporated with a capital of \$16,000, to manufacture leather products. The incorporators are S. S. Sush, I. Levin and J. E. Rivlin. The company is represented by Harry Levin, 132 Nassau St., New York.

THE DAVIS CHEMICAL CO., 12 West Park St., Providence, R. I., has filed notice of

organization to manufacture chemical products. George D. Mitchell heads the company.

THE AMERICAN MICA MINING CO., Newport News, Va., has been incorporated with a capital of \$250,000, to operate mica properties and manufacture mica products. Allan D. Jones, Newport News, is president; and H. C. Field, Axton, Va., secretary.

THE BLACK SEAL LUBRICANT CO., INC., 1305 Maryland Ave., Baltimore, Md., has been incorporated with a capital of \$100,000, to manufacture oils, greases and other lubricants. The incorporators are James G. Paugh, Frank H. Kelley and Peter Peck.

THE KALCO PRODUCTS CO., INC., New Haven, Conn., has been incorporated with a capital of \$10,000, to manufacture alkalis, chemicals and affiliated products. The incorporators are David Kaltman, Henry Zatulove and S. A. Skiff, 19 Congress Ave., New Haven.

THE ROSS LABORATORIES, INC., Philadelphia, Pa., has been incorporated with a capital of \$100,000, to manufacture chemicals, dyestuffs, colors and affiliated products. The company is represented by the Corporation Guarantee & Trust Co., Land Title Bldg., Philadelphia.

New Publications

"HANDLING LIQUID CHLORINE" is the title of a four-page leaflet containing D. K. Bartlett's paper read before the National Safety Council Congress at Boston, Sept. 28, 1921.

NEW BUREAU OF STANDARDS PUBLICATIONS: Circular 8, Testing of Thermometers; Circular 114, Standard Specifications for Cotton Rubber-Lined Fire Hose; Sci. Paper 410, Thermal Expansion of Copper and Some of Its Important Industrial Alloys, by Peter Hildner; Sci. Paper No. 413, A Portable Vacuum Thermopile, by W. W. Coblenz; Sci. Paper 414, Interference Measurements in the Spectra of Argon, Krypton and Xenon, by W. F. Meggers; Sci. Paper 416, Preparation of Galactose, by E. P. Clark; Tech. Paper 190, "Black Nickel" Plating Solutions, by George B. Hogaboom, T. F. Slattery and L. B. Ham; Tech. Paper 191, Some Factors Affecting the Life of Machine-Gun Barrels, by W. W. Sveshnikoff; Tech. Paper 192, Tests of Centrifugally Cast Steel, by George K. Burgess; Tech. Paper 195, Zinc Cyanide Plating Solutions, by William Blum, F. J. Liscomb and C. M. Carson.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 186, Investigations of Zirconium, With Especial Reference to the Metal and Oxide. Historical Review and Bibliography, by J. W. Marden and M. N. Rich; Bull. 206, Petroleum Laws of All America, by J. W. Thompson; Tech. Paper 261, Oil-Camp Sanitation, by C. P. Bowie.

THE COLORADO SCIENTIFIC SOCIETY, Denver, Col., has issued booklets on "Aspects of Colorado's Oil Shale Industry," by Arthur J. Hoskins, and "The Manufacture of Lubricating Products From Wyoming and Colorado Crude Oils," by L. C. Welch.

THE MILWAUKEE ASSOCIATION OF COMMERCE has just issued vol. 1 under date of August, 1921, of *Milwaukee*, a magazine for business leaders. C. B. Traver is editor and K. H. MacArthur business manager. Editorial contents are devoted to the forwarding of local industries.

BATLEY MFG. CO., of Milwaukee, Wis., has issued a new folder on the Batley Thermo-unit for heating and ventilating. This device is a new one and peculiarly adaptable for heating dye houses and small industrial buildings of all kinds. It is a complete indirect heating system with a heating surface consisting of individual spiral radiators, so valved that one or more coils may be cut out as temperature variations demand. The fan takes the air from the floor line, forces it through the heating coils into the room at about 6 ft. above the floor and returns it to the coils as it cools, thus forming a continuous cycle as long as heating is required. If desired, all or part of the air can be taken from the outside, thus combining ventilation with indirect heating.

THE UNIVERSITY OF MONTANA has issued a bulletin on "Geology and Oil and Gas Prospects of Central and Eastern Montana," by C. H. Clapp, Arthur Bevan and G. S. Lambert.

THE STATE OF LOUISIANA, DEPARTMENT OF CONSERVATION, has issued Bull. 9, on "The Monroe Gas Field," by H. W. Bell and R. A. Cattell, petroleum engineers of the U. S. Bureau of Mines.

"THE USE OF POWDERED FUEL UNDER STEAM BOILERS" is the title of a pamphlet recently published by the Combustion Engineering Corp., N. Y.

Capital Increases, Etc.

THE MERLIN KEILHOLZ PAPER CO., 296 Broadway, New York, N. Y., has filed notice of increase in capital from \$150,000 to \$250,000.

THE MUTUAL OIL CO., Adrian, Mich., has filed notice of increase in capital from \$45,000 to \$100,000.

THE IROQUOIS FOUNDRIES, INC., Utica, N. Y., has filed notice of dissolution under state laws.

THE DOVAN CHEMICAL CO., a Delaware corporation, has filed notice of intention to operate in New Jersey for the manufacture of chemical products. Kenneth A. Christian, 441 Riverside Ave., Newark, N. J., represents the company.

THE MAYWALD RUBBER CO., Nutley, N. J., manufacturer of rubber products, has arranged for the sale of a preferred stock issue, the entire distribution to total \$250,000. The proceeds will be used for expansion. Frederick J. Maywald is president, and George C. Plummer, vice-president and treasurer.

THE OLYMPIC CHEMICAL CO., 954 Leggett Ave., New York, N. Y., has filed notice of increase in capital to \$20,000.

THE BRADSTREET OIL CO., Tulsa, Okla., has filed notice of increase in capital from \$200,000 to \$1,000,000.

Coming Meetings and Events

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE will hold its seventy-fourth meeting at Toronto, Canada, Dec. 27 to 31, 1921.

AMERICAN CERAMIC SOCIETY will hold its twenty-fourth annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN ENGINEERING COUNCIL will hold its next meeting in Washington, Jan. 5-6.

AMERICAN FOUNDRYMEN'S ASSOCIATION will hold its next convention and exhibit at Cleveland, O., during the week of April 24, 1921. Meetings will be held in the spring instead of in the fall as heretofore.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Emerson Hotel.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting in New York the week of Feb. 20, 1921.

AMERICAN PETROLEUM INSTITUTE will hold its second annual meeting at the Congress Hotel, Chicago, Dec. 6, 7 and 8.

COLLEGE OF THE CITY OF NEW YORK, department of chemistry, will give public lectures under the auspices of the City College Chemical Society in the Doremus Lecture Theater, at 4:30 p.m., as follows: Nov. 30, "Afterthoughts of the War," by Leland L. Summers, of the War Industries Board; Dec. 6, "America in Chemistry," by Dr. Edgar F. Smith, provost emeritus, University of Pennsylvania, and president, American Chemical Society.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettin's Restaurant, 843 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting; Jan. 6—American Chemical Society, regular meeting; Jan. 13—Society of Chemical Industry, Perkin Medal; Feb. 10—American Electrochemical Society (in charge), Society of Chemical Industry, Société de Chimie Industrielle, American Chemical Society, joint meeting; March 10—American Chemical Society, Nichols Medal; March 24—Society of Chemical Industry, regular meeting; April 21—Society of Chemical Industry (in charge), American Electrochemical Society, Société de Chimie Industrielle, American Chemical Society, joint meeting; May 5—American Chemical Society, regular meeting; May 12—Société de Chimie Industrielle (in charge), American Chemical Society, Society of Chemical Industry, American Electrochemical Society, joint meeting; May 19—Society of Chemical Industry, regular meeting; June 9—American Chemical Society, regular meeting.